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Barbara, Meader and Pifher Townships

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D.U. Kresz and B. Zayachivsky

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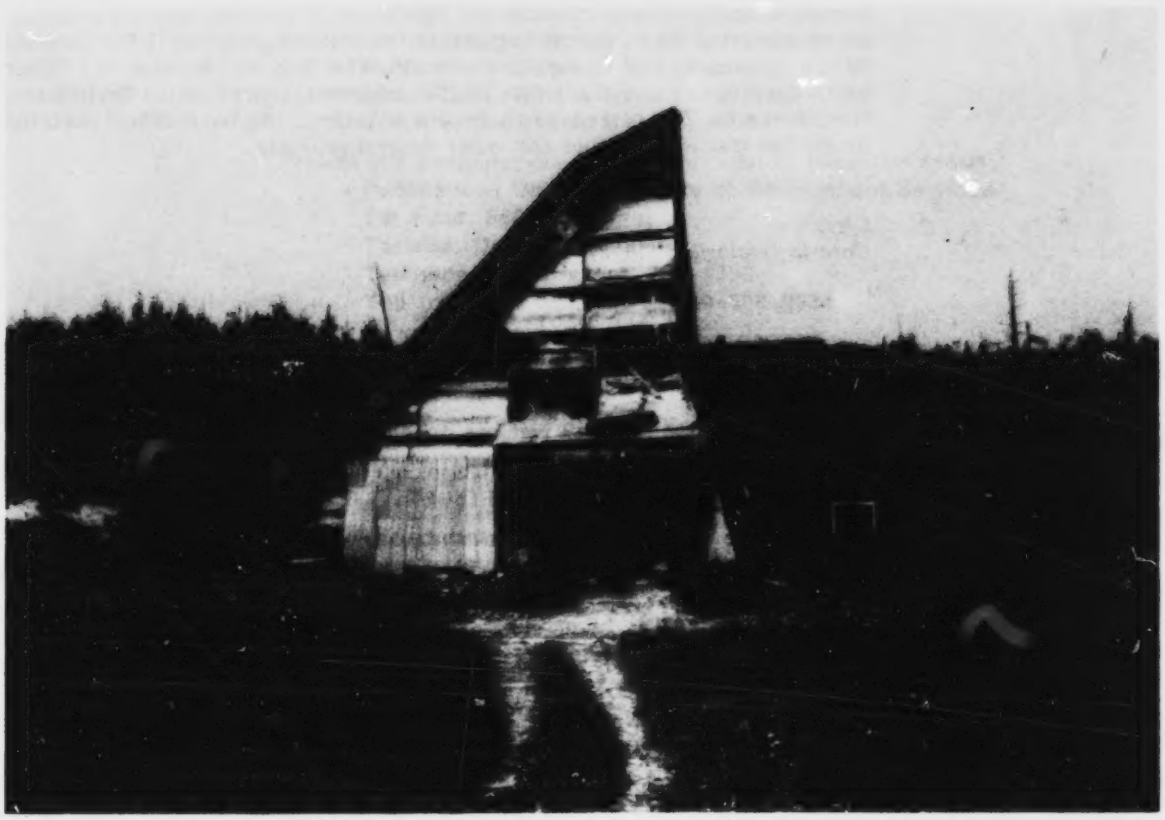
Foreword

Detailed geological information is essential for effective mineral exploration and as a basis for land use potential evaluation. Prior to 1986, the information available for the Barbara, Meader and Pifher townships area was limited to a reconnaissance and preliminary level. The area hosts several precious metal occurrences, three of which are located in Pifher Township and have produced gold: the Sturgeon River Mine, the Crooked Green Creek Mine and the Greenoaks Mine. Base metal occurrences are found in Pifher and Meader townships.

The detailed mapping project described in this report is one component of the Canada–Ontario Mineral Development Agreement (COMDA), which is a subsidiary agreement to the Economic Regional Development Agreement (ERDA) signed by the governments of Canada and Ontario. The Barbara, Meader and Pifher townships project is one of several COMDA initiatives targeted on the Beardmore–Geraldton area. This part of the province is considered to have excellent potential for further discovery of gold and other mineral resources.

V.G. Milne

Director
Ontario Geological Survey



Frontispiece: *The Crooked Green Creek Mine, view of the headframe. In the early nineteen seventies, the mine had the distinction of being "the smallest producing mine in Ontario". Photograph by J.F. Scott, 1975.*

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

Precambrian Geology Barbara, Meader and Pifher Townships

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Abstract

This report describes the geology, mineral deposits and exploration history of Pifher, Meader and Barbara townships which cover an area of 240 km² east of Lake Nipigon.

The bedrock underlying the three townships consists entirely of Precambrian metavolcanic and intrusive rocks of the eastern Wabigoon Subprovince within the Superior structural province, except for Proterozoic units at Lake Nipigon that are considered part of the Southern structural province.

The oldest rocks are Archean metavolcanics consisting of 1) massive and pillowed basaltic flows and related gabbro intrusions, and 2) felsic volcanic rocks represented by an extensive flow and by pyroclastics of intermediate to felsic composition. The latter are composed of lithic and crystallophyric tuff, lapilli tuff and tuff breccia. The fragmental metavolcanics have an essentially monolithic character in southern Pifher and Meader townships, whereas they are heterolithic in the northern and western part of the map area. Related felsic intrusions are represented by quartz and feldspar porphyry dikes and stocks. The intermediate to felsic metavolcanics are intruded in several places by diorite to quartz diorite stocks emplaced prior to the main tectonic event. A small batholith of tonalite to granodiorite intrudes the metavolcanics around North Wind Lake and is named the North Wind Lake pluton. The pronounced metamorphic strain aureole around the intrusion indicates a syntectonic emplacement.

All supracrustal rocks have undergone prograde metamorphism of low-grade, greenschist type, except near the batholith where an aureole of medium-grade metamorphism is observed. Retrograde metamorphism is evident in several areas where rocks have been locally metasomatized. Metasomatism was accompanied by the introduction of sodium, potassium, silica, and boron, and by the local formation of pumpellyite.

The volcanic assemblage forms a south-facing homoclinal succession that is largely overturned and forms part of a broad regional anticlinal structure intruded by the North Wind Lake pluton. Primary volcanic structures have been well-preserved in the southern part of the map area. However, in the northern part, structures and textures have been largely obliterated by metamorphic recrystallization.

Faults are not prominent structures in the area, relative to the Beardmore–Geraldton belt to the south. The most significant fault is the Musca Lake Fault which straddles the southern boundary of the map area. Numerous shear zones are present within the volcanic assemblage, particularly along geologic contacts.

During the Proterozoic, north-trending diabase dikes intruded all Archean rock types. An extensive sill, dated at 1108.8^{+4}_{-2} Ma, overlies the Archean rocks near Lake Nipigon.

During the Pleistocene, till, glaciofluvial and glaciolacustrine sediments were deposited on the peneplained Precambrian Shield; however, these are not extensive within the map area.

Gold has been the main economic interest of the region since the 1930s and numerous deposits are found within the map area. The gold mineralization is classified as 1) quartz veins in both shear zones and tension fractures, and 2) shear zones mineralized with sulphides. Gold deposits have been noted to have a close spatial association with 1) pretectonic granitic rocks of intermediate composition, 2) major east-trending faults (shear zones), 3) tight folds, 4) topographic lineaments, and 5) zones of pervasive metamorphism. Disseminated base metal sulphide deposits of epigenetic origin occur within auriferous quartz veins and shear zones; in order of decreasing abundance these sulphides are chalcopyrite, sphalerite and galena. Silver is found, in varying amounts, with gold.

A porphyritic diabase in Pifher Township has some potential for building and ornamental stone. Sand and gravel deposits are abundant in Pifher Township. The area is well situated for mineral development, being readily accessible by road and having energy sources close by.

Résumé

Dans ce rapport sont décrits la géologie, les gîtes minéraux et l'exploration minière des cantons de Pifher, Meader et Barbara qui couvrent une surface d'environ 240 km² à l'est du lac Nipigon.

Le substratum des trois cantons est constitué entièrement de roches volcaniques et de roches intrusives métamorphisées appartenant à la partie orientale de la sous-province de Wabigoon au sein de la Province structurale Supérieure. Des roches intrusives Protérozoiques près du lac Nipigon sont considerées comme faisant partie de la Province structurale du Sud.

Les roches les plus anciennes sont des roches métavolcaniques comprenant 1) des coulées basaltiques massives et coussinées avec des intrusions de gabbro qui leur sont associées, et 2) des roches volcaniques felsiques qui sont représentés par des coulées et des pyroclastites de composition intermédiaire à felsique. Les pyroclastites comprennent des tuffs lithiques et à phénocrystaux, tuffs à lapillis et tuff brèches. Les roches volcaniques clastiques ont un caractère monolithique dans la partie sud des cantons de Pifher et Meader, tandis qu'elles ont un caractère hétérolithique dans la partie nord et ouest de la zone cartographiée. Les intrusions felsiques associées aux roches volcaniques sont représentées par des dykes et des petits massifs intrusifs de porphyre à phénocrystaux de feldspath et de quartz. Les roches métavolcaniques de composition intermédiaire à felsique sont intrudées en plusieurs endroits par des petits massifs de diorite et de diorite quartzique qui se sont mis en place avant l'épisode tectonique principale. Un petit batholite de tonalite et granodiorite est intrusif dans les roches volcaniques autour du lac North Wind. Celui-ci a été nommé le pluton de North Wind Lake. Autour du batholite, l'auréole métamorphique et de déformation indique que l'intrusion est contemporaine du tectonisme dominant.

Toutes les roches supracrustales ont subies les effets d'un métamorphisme progressif de faible gradient du type des schistes verts à l'exception de la périphérie du batholite de North Wind Lake où les roches ont subi les effets d'un métamorphisme de contact de gradient modéré. Le rétrométamorphisme est évident en plusieurs endroits où les roches ont subi localement une métasomatose qui se caractérise par l'apport de sodium, potassium, silice, bore et la présence en un endroit de pumpellyite. La séquence volcanique constitue une structure monoclinale déversée à polarité sud, appartenant à une vaste structure anticlinale intrudée par le pluton de North Wind Lake. Les structures volcaniques primaires ont été bien conservées dans la partie sud de la zone cartographiée, cependant au nord, les structures et textures ont été en grande partie oblitérées par une forte contrainte et par la recristallization métamorphique.

Les failles ne sont pas des structures proéminantes dans la zone cartographiée en comparaison avec la ceinture de Beardmore-Geraldton située plus au sud. La faille la plus marquée est la faille de Musca Lake qui chevauche la limite sud de l'aire cartographiée. De nombreuses zones de cisaillement sont présentes dans la séquence métavolcanique, en particulier le long des contacts géologiques.

Pendant le Protérozoique, des dykes de diabase orientés nord-sud ont recoupé toutes les séries Archéennes. Un filon-couche de diabase de grande, étendue daté à 1108^{+4}_{-2} Ma, recouvre les roches archéennes près du Lac Nipigon.

Au cours du Pléistocène, des tills et des sédiments glacio-fluviaux et glaciolacustres ont été déposés sur le bouclier Précambrien pénéplané. Ces dépôts ne sont jamais très importants au sein de la zone cartographiée.

L'or a été l'intérêt économique principal de la région depuis les années 1930 et de nombreux gîtes aurifères ont été découverts à l'intérieur de la zone cartographié. Ces gîtes ont été classés comme suit 1) filons de quartz associés avec des zones de cisaillement et des fissures d'extension, 2) zones de cisaillement minéralisées en sulfures. Les gisements d'or présentent une association intime dans l'espace avec 1) des roches granitiques anté-tectoniques de composition intermédiaire, 2) des failles majeures (zones de cisaillement) avec une orientation vers l'est, 3) des plis sérrés, 4) des linéaments topographiques, et 5) des zones de

métasomatose. Des sulfures non-ferreux disséminés d'origine épigénétique se trouvent parmi les filons de quartz aurifères et les zones de cisaillement. Par ordre décroissant d'abondances ces sulfures comprennent la chalcopyrite, blende et galène. L'argent, en teneur variable, est associé avec l'or.

Un dyke de diabase à phénocrystaux dans le canton de Pifher pourrait être utilisé comme pierre de construction et/ou ornementale. Des dépôts de sable et de gravier sont nombreux dans le canton de Pifher. Enfin notons que le developpement des ressources minières de la zone cartographiée est favorisé par des voies d'accès en bon état et des sources d'énergie proches.

Precambrian geology, Barbara, Meader and Pifher townships, by D.U. Kresz and B. Zayachivsky, Ontario Geological Survey, Report 270, 91p. Published 1989. ISBN 0-7729-6083-6.

Introduction

LOCATION AND ACCESS

Barbara, Meader, and Pifher townships lie on the eastern side of Lake Nipigon and are bounded by latitudes 49°45′00″N and 49°50′30″N and by longitudes 87°46′W and 88°09′W (Figure 1). They cover an area of 240 km². Beardmore, the nearest town, is 35 km by road from the southern boundary of Pifher Township. The city of Thunder Bay is located 190 km from Beardmore via route 11 of the Trans-Canada Highway.

Pifher and Meader townships are accessible by road. Provincial Road 801 commences at Highway 11, 10 km west of Jellicoe and provides access to the eastern part of Pifher Township. Alternate access is provided by a branch of Highway 580 linking Beardmore to the southern part of Pifher and Meader townships. A gravel road connects these two routes in southern Pifher Township and continues into Meader Township. Several abandoned lumber roads provide access to North Wind, Tyrol, Schroder, and Pifher lakes. Barbara Township is most easily reached by boat from Lake Nipigon or by float-equipped aircraft.

PRESENT GEOLOGICAL SURVEY

The field work carried out during the summer of 1986 consisted of mapping the Precambrian bedrock and mineral deposits. Pace-and-compass traverses were run at 300 to 400 m intervals but closer intervals were used in areas of abundant outcrop underlain by metavolcanic rocks. Vertical aerial photographs at a scale of 1:15 840 (1 inch to 1/4 mile) provided by the Surveys and Mapping Branch, Ontario Ministry of Natural Resources, were used for plotting coded information in the field and for planning traverses from stereoscopic interpretation of the land surface. Geology is tied to the road network, lake shores, and recently surveyed exploration grids established by Peddle Lake Mining Corporation and Noranda Exploration Limited in southern Pifher Township; it is not tied to claim lines or surveyed township boundaries. All field data have been transferred on 1:15 840 scale base maps derived from Forest Resources Inventory maps with additional changes by the authors during the course of mapping. A detailed geological map at a scale of 1:1000 has been prepared for an area south of Peddle Lake where overburden stripping and trenching produced good exposure in 1985 and 1986.

A large number of rock samples have been collected in the process of mapping. Of these, 94 were submitted for assays, principally gold and silver, 95 for thin sectioning and 54 for whole rock analysis. A summary of field work (Kresz and Zayachivsky 1986) was published in December 1986. Uncoloured preliminary geological maps, first issued in 1987, were subsequently revised and reissued as P.3078 (Revised) covering Pifher Township and P.3077 (Revised) covering Meader and Barbara townships at a scale of 1:15 840, by the Ontario Geological Survey.

HISTORY OF MINING AND EXPLORATION

Mineral exploration in the region began at the turn of the century when iron was discovered in the Lake Nipigon iron ranges along the Namewaminikan (Sturgeon) River and in the Poplar Lodge–Windigokan Lake area (Coleman 1907; Moore 1907; Coleman

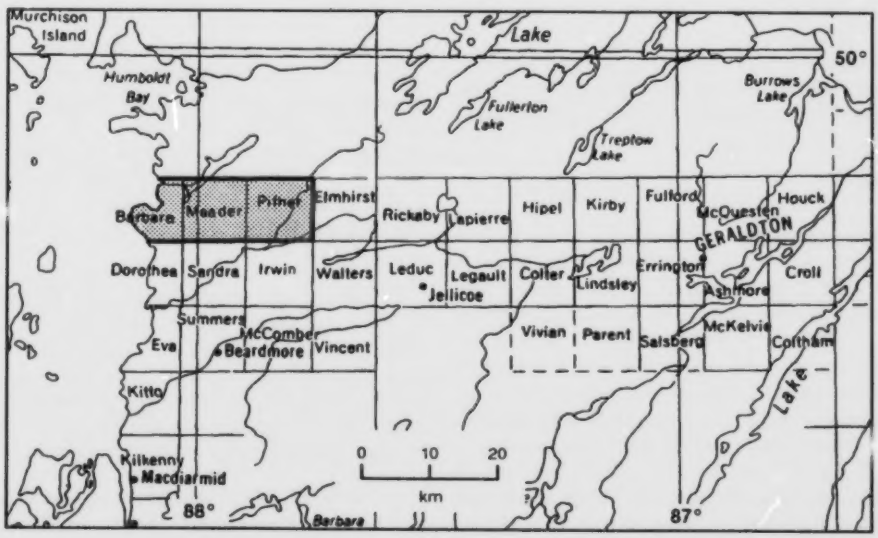

Figure 1. *Key map showing the location of Barbara, Meader and Pifher townships.*

and Moore 1908); however, no economic successes occurred.

Gold was discovered in 1925 near Beardmore at the site of the Northern Empire Mine. Since its discovery, gold has been one of the main minerals sought in the region. The first gold discovery in the Sturgeon River area was made in 1934 at the Maloney–Sturgeon prospect in Pifher Township and was described then as a "spectacular" find (Laird 1936). The find was a small, very rich ore pocket from which a total of 94 ounces of gold and 16 ounces of silver were recovered in 1935 and 1937. The discovery immediately sparked a gold rush along the Sturgeon River, leading subsequently to further discoveries (Laird 1936). Among those were the Sturgeon River Mine which started production in 1936. Between then and 1942, 73 438 ounces of gold and 15 922 ounces of silver were produced. Gold exploration remained sporadic in the area.

A number of gold deposits with associated sulphides were also investigated for their base metal potential. Between 1947 and 1972, a copper-nickel deposit was thoroughly investigated in northwestern Elmhirst Township (Mackasey and Wallace 1978).

In the early 1980s gold exploration was revived. Following discovery of a deposit at the Brookbank zone by Metalore Resources Limited (*The Northern Miner*, March 24, 1986) in central Irwin Township and a new gold occurrence near Twin Falls in northwestern Irwin Township by Noranda Exploration Company, Limited, the region underwent a staking rush. As a consequence, most of the ground in Pifher, Meader, and Barbara townships not underlain by granitic rocks and Proterozoic diabase was solidly staked. Recent mining activity has been essentially confined to the Crooked Green Creek Mine, and the Greenoaks Mine. At the Crooked Green Creek Mine some 1900 tons of ore were extracted from two zones between 1980 and 1984. At the Greenoaks Mine, 1224 tons of ore were reportedly mined in 1982 (Mason and White 1986); during the summer of 1986, much of the main vein was quarried from the surface.

PHYSIOGRAPHY

The area has a peneplain topography typical of the Precambrian Shield, with Lake Nipigon to the west lying at an elevation of 260 m above sea level. The highest elevation in the area is a wide hill, west of Forge Lake in Pifher Township, which reaches a maximum height of 427 m above sea level; it is underlain by Archean mafic metavolcanic rocks and gabbro. The dominant land form is gently rolling hills with low areas that are occupied by lakes, swamps, marshes and bogs. North Wind Lake is the largest lake within the map area. Proterozoic diabase sills are sharply bounded by cliffs or steep slopes that dominate the lower Archean terrain and give rise to a cuesta-like topography such as at Peddle Lake or in southwestern Meader Township. Surface features are somewhat related to bedrock structure, which is accentuated by glacial erosion giving rise to linear lakes, streams and topographic lows. Bedrock exposure is abundant throughout the map area except in a few low-lying places occupied by cedar and spruce swamps, and muskeg. The area is generally well drained through the Namewaminikan (Sturgeon) River, Crooked Green Creek and the Tyrol River, each of which flows into Lake Nipigon.

PREVIOUS GEOLOGICAL WORK

According to Laird (1936, p.63) the earliest record of geological investigation in the Lake Nipigon region is that of Robert Bell and Peter McKellar of the Geological Survey of Canada, in 1869. The work was largely confined to the shoreline of Lake Nipigon and its tributary rivers. Their work was continued in 1894 by W. McInnes, and in 1898 by D.B. Dowling. In 1908, A.W.G. Wilson completed a survey for the Geological Survey of Canada in the Lake Nipigon region (Wilson 1910).

In 1901, W.A. Parks traversed some of the region to the north and south of the Namewaminikan (Sturgeon) River. The search for iron at that time led to the survey of the Poplar Lodge and Sturgeon River areas by Coleman (1907), and the Windigokan Lake area by Moore (1907) and Coleman and Moore (1908). In 1935, H.C. Laird and E.L. Bruce of the Ontario Department of Mines mapped 17 townships on the east side of Lake Nipigon as part of a reconnaissance survey extending from Lake Nipigon to Hipel and Colter townships, including Pifher and Meader; work is described in a comprehensive report (Bruce 1936; Laird 1936) which provided helpful information used in the present report. Barbara, Meader and Pifher townships were later investigated by W.O. Mackasey (1970a, 1971) as part of a multiyear mapping program in the Beardmore–Jellicoe area that included the following townships: Dorothea, Sandra and Irwin townships (Mackasey 1975); Walters and Leduc townships (Mackasey 1976b); Legault and Colter townships (Mackasey et al. 1976a, b); Elmhirst and Rickaby townships (Mackasey and Wallace 1978); Eva and Summers townships (Mackasey 1970c, d); and Lapierre and Hipel townships (Mackasey 1974).

The present map area is encompassed by two Ontario Geological Survey compilation maps: Map 2102, Tashota–Geraldton Area (Pye et al. 1966); and Preliminary Map P.257, Lake Nipigon (Stott 1984). Geophysical coverage is available from ODM–GSC Aeromagnetic Series Maps 2129G (1963a), 2136G (1963b) and 30 002G (1974).

Table 11 lists assessment work data on file with the Ontario Geological Survey in Toronto, and the Beardmore–Geraldton Resident Geologist's office in Thunder Bay, as of December 1986.

ACKNOWLEDGMENTS

The authors were provided with the able assistance of Virginia Heffernan, Richard Desaulniers and Rodney Moore who also carried out some independent mapping. John and Ellen Fevez of the Pasha Lake Camp provided many appreciated services and courtesies during the summer of 1986. Excellent service was also given by the staff of the Ministry of Natural Resources in McDiarmid. Kyro's Airways of Jellicoe supplied air transportation in the field during the later part of the field season. John Mason of the Resident Geologist's Office in Thunder Bay took a great interest in the mapping program and supplied much useful information. Michael Hine, also from the Thunder Bay office, compiled a list of properties and ownerships. P.C. Thurston and H.R. Williams provided much insight into volcanology and structural geology through excursions into the field; they also revised and provided suggestions to the manuscript. W.D. Hicks of the Geoscience Laboratories in Toronto carried out numerous mineral identifications. L.O. Koskitalo and V. Shein of Phoenix Gold Mines Limited provided information and tours on the Sturgeon River property.

General Geology

INTRODUCTION

Barbara, Meader and Pifher townships are situated in the eastern part of the Archean Wabigoon Subprovince (Goodwin 1970) and are part of the southern portion of a metavolcanic-plutonic belt referred to as the Tashota–Onaman belt (Amukun 1980; Mason and White 1986) (Figure 2). This belt is bounded by large granitic batholiths to the east and west.

To the south, the Tashota–Onaman belt is bounded by an east-trending, 100 km long, linear belt composed predominantly of mafic volcanic and sedimentary rocks (Pye et al. 1966; Stott 1984) commonly referred to as the Beardmore–Geraldton belt (Mackasey 1970b; Kehlenbeck 1986; Williams 1986). This belt is structurally dominated by east-trending ductile-brittle dextral shear zones which occur at the boundaries of north-facing lithostratigraphic units (Williams 1986).

In contrast, the Tashota–Onaman belt appears to be folded about the intrabelt granitic intrusions. The Paint Lake Fault, a major ductile-brittle deformation zone (Reilly and Williams 1986) marks the boundary between the north-facing Beardmore–Geraldton belt and the Tashota–Onaman belt, which in its southern part youngs to the south (*see* Figure 2). Moreover, the pronounced lithologic asymmetry and change in structural style on either side of the Paint Lake Fault (Mackasey 1972) suggests the Beardmore–Geraldton belt and the Tashota–Onaman belt have different structural styles. Following regional structural studies, Williams (1986) suggests that the Beardmore–Geraldton belt represents a fore-arc accretionary prism. This interpretation may lead to new constraints as to the positioning and nature of the Quetico–Wabigoon Subprovince boundary which has in the past been considered to be a stratigraphic feature in the Beardmore–Geraldton area (Ayres 1969; Mackasey et al. 1974).

The supracrustal rocks in Barbara, Meader and Pifher townships are dominated by proximal, felsic to intermediate volcanic rocks; mafic volcanics; and related gabbro intrusions. These rocks are intruded by pretectonic granitic rocks of intermediate composition. During the main tectonic event, large-scale tonalite to granodiorite plutons intruded the supracrustal assemblage producing large folds. Intrusions such as that centred on North Wind Lake, here called the North Wind Lake pluton, have produced a pronounced metamorphic and strain aureole and hence are considered syntectonic. Within the three townships, the southward younging volcanic assemblage dips steeply north, implying an overturned sequence. The metamorphic foliation parallels stratigraphy and becomes more pronounced close to the North Wind Lake pluton.

Faults are not common within the map area; the most significant of these is the Musca Lake Fault which may be considered to be the northernmost structure of the numerous east-trending shear zones that characterize the Beardmore–Geraldton belt.

During the Proterozoic, all Archean rocks were intruded by north-trending diabase dikes of two types: a less common plagioclase porphyry type, and a more common non-porphyritic type. An extensive mafic sill, related to the Lake Nipigon diabase sills, occurs in the eastern part of the area.

The Precambrian bedrock has been covered by till and sand deposits during the last ice age; these are not extensive over the map area.

Table 1 presents the principal lithologies that underlie Barbara, Meader and Pifher townships.

PRECAMBRIAN

ARCHEAN

Metavolcanic Rocks

Within the map area, the supracrustal assemblage consists entirely of volcanic rocks and related intrusions. Mafic volcanic rocks underlie a large area in Pifher and Meader townships and a smaller area in Barbara Township. Both bodies probably belong to the same stratigraphic unit as the gap separating them is believed to be erosional. Felsic to intermediate volcanic rocks of dacitic to andesitic composition represent the most widespread rock type within the map area, as they form a continuous sequence from eastern Pifher Township to the shore of Lake Nipigon in Barbara Township. Rhyolitic compositions are scarce. Facing data indicate the volcanic assemblage faces southwards.

MAFIC VOLCANIC ROCKS

Mafic volcanic rocks occur in two distinct areas, as mafic flows and gabbro. The largest mafic unit forms a 16 km long teardrop-shaped area in Pifher and Meader townships which is 4.5 km wide in Pifher Township. The second outcrop area of mafic metavolcanic rocks is in the central and northern part of Barbara Township. The two areas are separated by a 2.5 km gap underlain by felsic volcanic rocks. The lithologic similarity of the mafic metavolcanic rocks in these two areas, coupled with the fact that the contact between the mafic and the felsic volcanic assemblages dips northward at a very shallow angle, suggests that the gap is erosional. Therefore, the mafic metavolcanics are described as a single unit which extends from central Pifher Township to Lake Nipigon. The only difference between the two mafic terrains is the relative proportion of extrusive rocks to gabbro: the exposed mafic assemblage underlying Pifher and

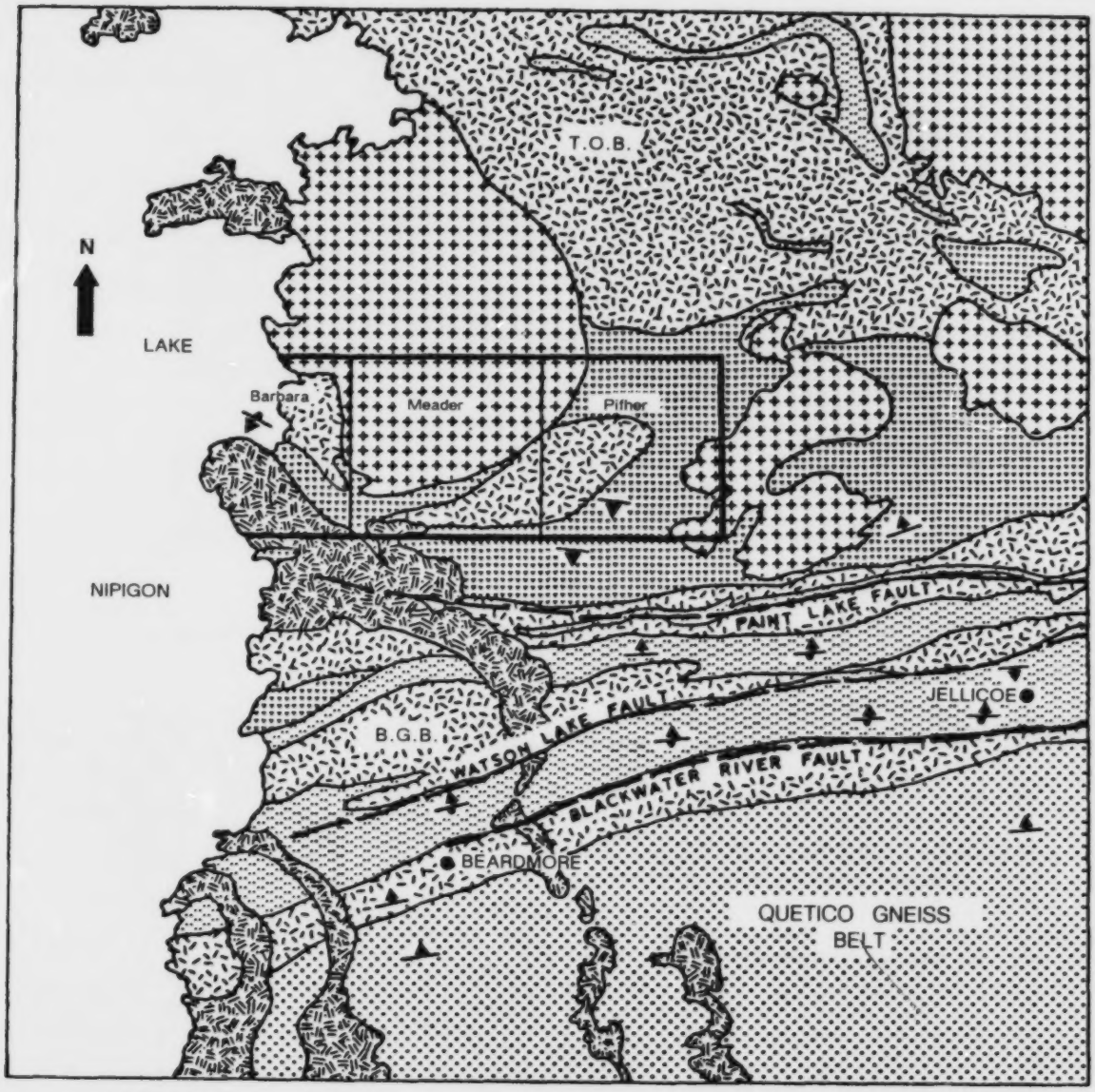

Figure 2. *Geological sketch map of the Beardmore area showing the major subdivisions of the eastern Wabigoon Subprovince; drawn using data from Pye et al. (1966), Stott (1984) and Williams (1986).*

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR PIFHER, MEADER AND BARBARA TOWNSHIPS.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Peat, lake and stream deposits

PLEISTOCENE

Till, sand and clay

Major Unconformity

PRECAMBRIAN

PROTEROZOIC

MAFIC INTRUSIVE ROCKS

Plagioclase porphyritic diabase dikes, diabase dikes and sills

Intrusive Contact

ARCHEAN

FELSIC INTRUSIVE ROCKS

North Wind Lake Pluton

Quartz diorite, tonalite, granodiorite, quartz monzonite, granite, pegmatite

Intrusive Contact

INTERMEDIATE PLUTONIC ROCKS*

Diorite, quartz diorite, tonalite

Intrusive Contact

FELSIC TO INTERMEDIATE HYPABYSSAL ROCKS

Feldspar-amphibole porphyry, feldspar porphyries, feldspar-biotite porphyry, feldspar-quartz porphyries

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

Pyroxenite(?), gabbro, basalt, lamprophyre

Intrusive Contact

FELSIC TO INTERMEDIATE METAVOLCANICS

Tuff, crystal tuff, lapilli tuff, tuff breccia, massive and flow banded lava and related breccia; derived chlorite to sericite schists

Conformable Contact

LOCALLY INTERCALATED MAFIC METAVOLCANICS

Massive and pillowed basalt flows and derived breccia, derived chlorite schist

** The terminology used here follows the recommendations of the International Union of Geological Sciences (Streckeisen 1976).*

Meader townships is composed of roughly one third basalt and two thirds gabbro, whereas the western mafic area is dominated by extrusive rocks.

The transition between the mafic and the felsic assemblages is abrupt, except in Barbara Township where the transition is marked by the intercalation of felsic metavolcanics and mafic flows.

The mafic volcanic rocks are represented mainly by massive and pillowed basaltic flows. Pillows are usually small, ranging up to 1 m in size, and have well-defined chloritic selvages. In most places, pillows have been elongated during deformation; the deformation is particularly strong near the tonalite-granodiorite pluton that is centred on North Wind Lake. Where pillows are least deformed, in central Pifher Township, they may be used to determine top directions.

In many places, pillows have vesicular rims. Vesicles are generally small, up to several millimetres in diameter. Larger vesicles have been observed at an

Photo 1. *Two massive basalt flows separated by a laminated, felsic airfall tuff bed. Secondary structures have been produced by the overlying basalt unit (lefthand side of photo) that flowed over unconsolidated material thereby generating load structures such as the semi-detached pillow in the middle of the picture. Shoreline of Lake Nipigon, Barbara Township.*

outcrop on the south shore of Forge Lake where pipe-shaped vesicles up to 20 cm in length occur within a recrystallized pillow basalt. Secondary vesicle fillings consist of various combinations of iron-rich carbonate, quartz, chlorite, actinolite and albite. The vesicularity of flows increases southwards, suggesting a shallowing sequence.

This is also supported by the fact that gas cavities several centimetres across are found in andesitic tuff in southern Pifher Township. In Barbara Township, vesicle density within pillow rims increases towards the top of the pillow, an observation that may be used as a reliable top indicator in deformed pillows.

Mafic breccia units have been observed 1100 m to the southwest of Forge Lake, along a creek where the rock exposure forms a steep face up to several metres high. The brecciated units are up to several metres thick and are in sharp contact with fine-grained massive basalt that laterally grades into pillowed flows. The vesicularity within the massive basalt increases towards the brecciated part of the flow, which has been interpreted as flow top breccia formed partly through autobrecciation and quenching (hyaloclastite). Clasts, which normally range from 1 to 20 cm, are in close contact and have little hyalotuff matrix. A large rock exposure beside a small lake 300 m to the southwest of the flow top breccia exposure reveals well-formed pillows, up to 1 m in cross section, with vesicular rims and associated pillow breccia. The pillow lava exposures encountered in Pifher and Meader townships present a tightly packed arrangement with little pillow breccia and interpillow hyalotuff. In Barbara Township, within the flows along the shoreline of Lake Nipigon, pillow breccia is apparent in many places. In Pifher Township, shape and packing of pillows indicates a northward dip ranging between 30° and 50°.

Generally, individual mafic flows cannot be traced. In Barbara Township, however, the transition, between the basaltic rocks and the overlying felsic rocks to the south, is marked by an interlayering of massive to pillowed basaltic flows that are up to several tens of metres thick, and conspicuously stratified felsic tuffs (Photo 1).

The geometry of the basaltic sequence is complex. In Pifher Township the areas of basaltic flow are separated and surrounded by gabbro. On the map, the larger areas of flow rocks are highly irregular; the smaller areas are lens-shaped to linear. The elongation of these bodies clearly define an overall structure for the mafic flows. This structure trends northwest in Pifher Township and curves to a northeast direction in Meader Township, thus defining the general trend of units in south Meader Township.

Field observations indicate that gabbro intrusions are conformable with the basalts. The relatively rugged topography in central Pifher Township has allowed observation of the sharp contacts between gabbro and basalt. The contacts appear to dip northwards at angles between 30° and 50°, parallel to the mafic stratigraphy. Thus, the rather irregular outline of basaltic area in plan view is largely the result of shallow dipping units of limited thickness and a locally pronounced topography. Furthermore, the hill-

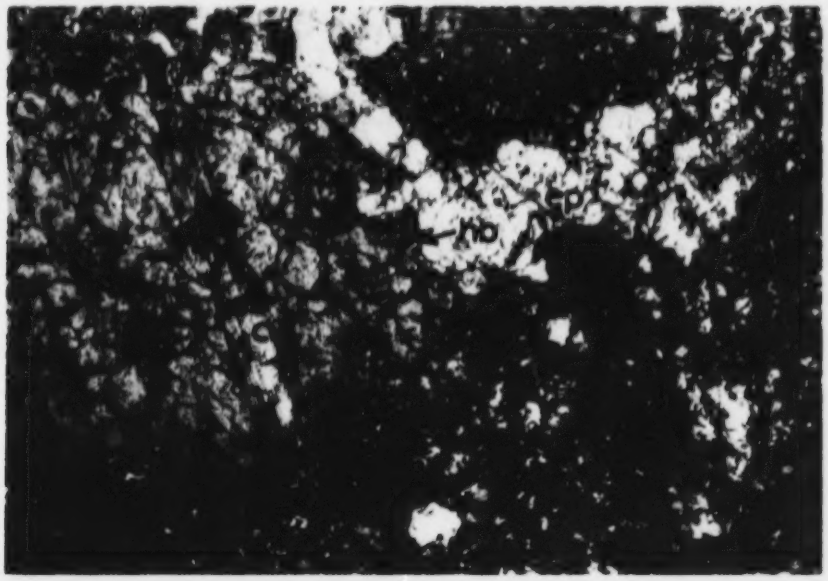

Photo 2. *Photomicrograph of a hornblende schist showing local development of cummingtonite (cu), abundant epidote (ep), and hornblende (hb). The lath shaped cummingtonite crystal is polysynthetically twinned. Northern Barbara Township; magnification: X85*

top surfaces in central Pifher Township are characterized by cuesta-like ridges, with steep scarps to the south and gentle slopes to the north, that reflect the layering of the mafic units.

In Barbara Township, the mafic volcanic assemblages contain less gabbro than in Pifher Township, which may be explained by a more distal volcanic source. The outline, in plan view, of the mafic intrusions, which are traceable up to several kilometres along strike, indicate they were emplaced as concordant units. Primary structures have been highly deformed or destroyed by intrusion of the North Wind Lake pluton which imposed a pronounced metamorphic and strain aureole upon the supracrustal rocks, transforming the basalts and related gabbros into hornblende schists. The presence of numerous mafic xenoliths within the granitic mass indicates that much of the lower mafic assemblage has been stoped by the intrusion.

Mafic tephra is uncommon within the map area and has been found only within the felsic volcanic rocks along the Lake Nipigon shoreline to the east of Mungo Park Point. It occurs 1) as thin mafic ash beds within compositionally layered tuffaceous layers; 2) forming the groundmass to matrix-supported volcanic fragmentals with felsic clasts; and 3) as minor lapilli tuff and tuff breccia beds intercalated within the felsic pyroclastic rocks.

Petrography The mafic metavolcanics are essentially non-porphyritic. Basalt carrying small plagioclase phenocrysts was noted in only one exposure, in northern Barbara Township. Primary textures and mineralogies have been largely destroyed by retrograde metamorphism. Original calcic plagioclase has degraded to albite, quartz and clinozoisite; original mafic minerals such as olivine and pyroxenes have altered chiefly to chlorite, actinolite and iron oxide.

At the periphery of the North Wind Lake pluton, rocks have been recrystallized to amphibole schists typically composed of hornblende, plagioclase and quartz. A hornblende schist close to the granitic contact in northern Barbara Township also contains cummingtonite (Photo 2).

In Barbara Township, interiors of pillows from many flows have been intensely epidotized. In outcrop, such pillows are typically olive green on the weathered surface.

Within the strain aureole of the North Wind Lake pluton, hornblende schists display a banded structure defined by boudinaged layers, tens of centimetres thick, which form lens-shaped masses of quartz, albite and epidote in a hornblende-rich rock (Photo 3). This layered structure is believed to represent highly deformed pillow basalt. In some places, the basalts have acquired a medium- to coarse-grained texture through recrystallization. Structures such as pillow margins and vesicles, which have commonly been preserved and even enhanced by higher metamorphic grades, are essential in distinguishing between extrusive and intrusive mafic rocks.

INTERMEDIATE TO FELSIC VOLCANIC ROCKS

Intermediate to felsic volcanic rocks of calc-alkalic affinity (*see* Petrochemistry) underlie roughly two thirds of the greenstone belt within the map area.

Photo 3. *Metamorphic layering in a hornblende schist. The boudinaged layers are epidote-, albite- and quartz-rich and probably represent deformed pillow cores. Northern Barbara Township.*

Stratigraphic facing indicators imply that these rocks overlie the mafic, tholeiitic volcanic rocks throughout the area. The boundary between tholeiitic and calc-alkalic volcanic rocks is sharp, except in Barbara Township where the contact is transitional. It is marked by the intercalation of mafic and felsic units over a vertical distance of approximately 1 km. In the field, the intermediate to felsic, calc-alkalic volcanic rocks are readily distinguished from the mafic tholeiitic volcanic rocks by their lower colour index.

The compositions of the calc-alkalic rocks range from andesite to dacite. Rocks which classify, in a chemical sense (greater than 68 percent SiO_2) as rhyolites, (cf. Carmichael et al. 1974) have been noted only locally and will be described separately.

The thickness of the calc-alkalic sequence cannot be ascertained because of variable dips, possible folding, and intrusions. However, from the extent of the rocks, and their facies relations, it appears that the thickest part lies in Pifher and Elmhirst townships and could well be of the order of 6 to 8 km. The calc-alkalic volcanic sequence is extensive, as it is continuous from Lake Nipigon in the west to Lapierre Township in the east, a distance of at least 55 km.

The nature of the volcanic rocks is highly diverse, including flows, volcanic breccias and a wide range of pyroclastic and epiclastic deposits. In this report the pyroclastic rocks have been described according to the classification system proposed by Fisher (1966) and Pettijohn (1975) (Figure 3a, Figure 3b).

During the course of field work, some difficulties were met in the identification of the various rock types because of the following factors:

1. Lack of diagnostic features that would discriminate between extrusive and intrusive rocks, such as crystal tuff versus intrusive porphyry, or porphyritic flows versus intrusive porphyry
2. The higher metamorphic grade in the northern part of Pifher Township generated pervasive recrystallization, totally or partially obliterating original textures and structures
3. Rocks within the strain aureole of the North Wind Lake pluton have been intensely deformed

Flows A single flow of andesitic composition has been traced unambiguously for 8500 m from north-central Pifher Township into southwestern Meader Township. It is well exposed along the southern contact of the mafic assemblage. However, most of the flow is exposed only through numerous erosional windows in mafic pillow basalt and gabbro, which structurally overlie it along a shallow, north-dipping surface.

The flow consists of several parts: 1) a massive, fine-grained zone which represents the flow interior; 2) an outer zone with flow lamination and spherulites; and 3) a brecciated carapace of felsic hyaloclastite (cf. Dimroth and Rocheleau 1979).

The area underlain by the flow has undergone relatively little deformation and primary structures are generally well preserved (Photo 4).

The interior of the flow is represented by massive, fine-grained, aphyric andesite with a dull grey colour on a fresh surface.

The outer part of the flow displays primary flow banding that in places is spectacular (Photo 4). The

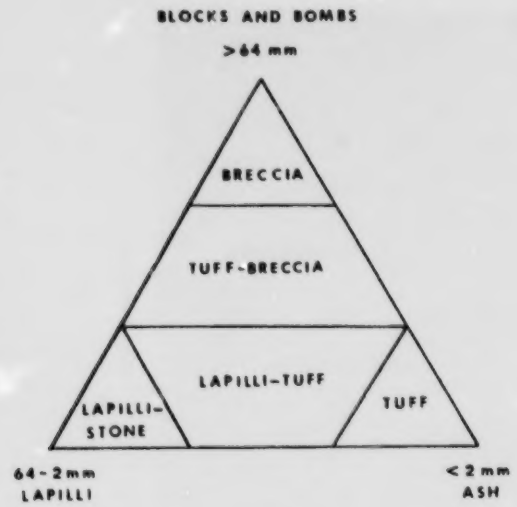

Figure 3a. *The system of classification of pyroclastic rocks after Fisher (1966).*

Figure 3b. *Classification of tuffs after Pettijohn (1975).*

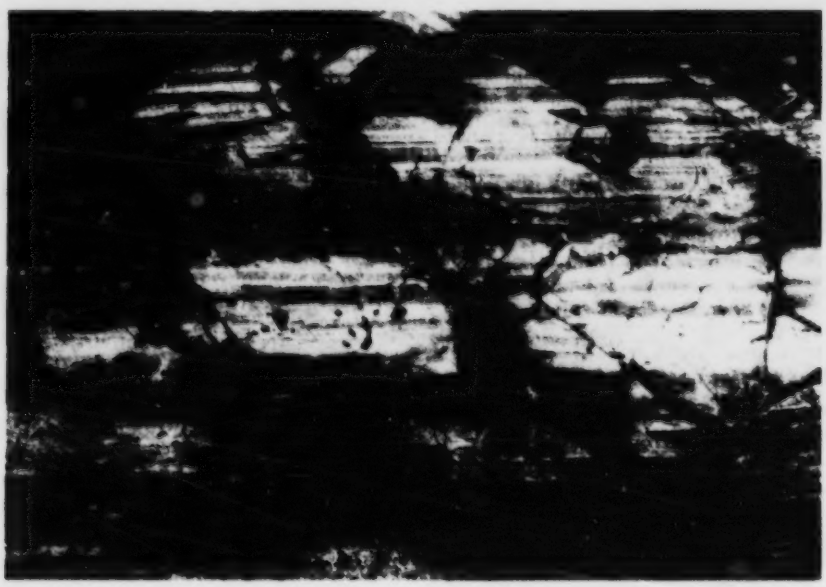

Photo 4. *Well-defined flow banding in the outer part of an extensive andesite flow. The rock represents a devitrified and recrystallized obsidian. Pifher Township.*

ribboned structure is characterized by fine, crystalline layers several millimetres thick alternating with cherty, lighter coloured bands. These cherty bands undoubtedly represent devitrified obsidian that resulted from the rapid cooling of the outer part of the flow. Under the microscope, the banding is characterized by textural differences and slight variations in the mafic mineral content between layers.

In several locations, the flow banded andesite displays spherical bodies to 1 cm across. These bodies occur as lighter or darker coloured spots with diffuse outlines which are due to differences in mafic mineral contents. They probably represent spherulites.

The outermost part of the flow is coarse rubbly breccia formed by the mechanical disruption of the

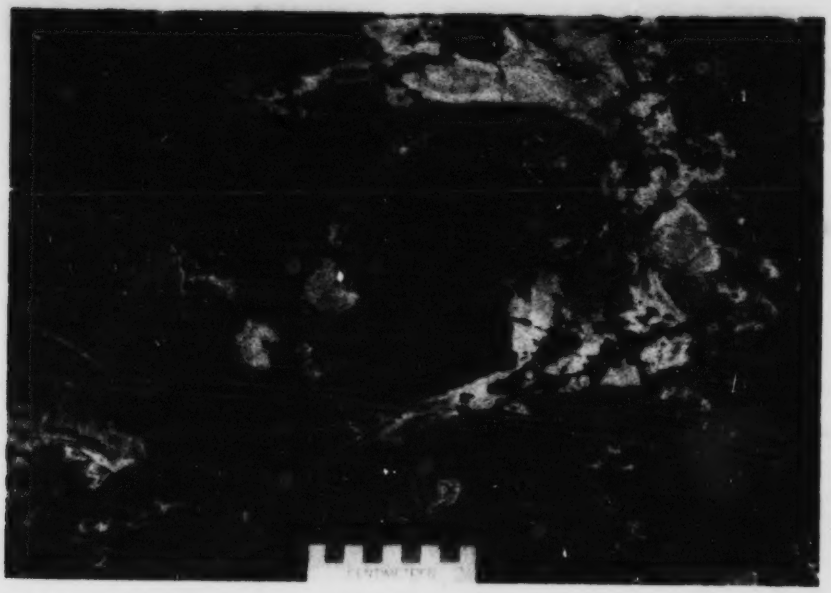

Photo 5. *Flow-top breccia showing numerous obsidian clasts and shards welded into andesitic holocrystalline fragments. The large obsidian fragment in the centre of the picture has been plastically deformed. Note the faint igneous banding. Pifher Township.*

moving viscous flow surface, i.e., autobrecciation. These autoclastic rocks contain highly angular unsorted clasts of holocrystalline lava and devitrified obsidian. The obsidian occurs as cherty clasts with convoluted flow lines, commonly displaying evidence of plastic deformation (Photo 5).

Hyaloclastite, consisting of microbreccia produced by quenching, is associated with this flow top. Chlorite-filled vesicles are associated with the more tuffaceous material which forms the matrix to the breccia and microbreccia. Structures associated with the flow unit that has been described in this report have previously been reported from the Rouyn–Noranda area in Quebec (Dimroth and Rocheleau 1979).

Spatially associated with the flow in central Pifher Township is a tuffaceous unit with elongated chloritic blebs 1 to 2 mm thick. These blebs are collapsed pumice fragments (fiamme). The fiamme, together with a lack of grading and bedding and increasing concentration of pumice upward, suggest the unit is an ash flow (cf. Fisher and Schmincke 1984). Also common within the unit are large, elliptical quartz amygdules, up to 5 cm in diameter, that provide a fine example of vesiculated tuff.

Felsic Pyroclastic Rocks Pyrociastic rocks, which form the bulk of the calc-alkalic volcanic assemblage in the area, range from fine-grained tuffs through coarse breccias. Preservation of primary textures and structures, necessary for the recognition of pyroclastic flows, debris flows and epiclastic units, has permitted interpretation of the genesis of most of these rocks. However, intense metamorphic recrystallization and deformation have obscured textures in northern Pifher Township and in Meader Township.

Based on the nature of the clasts, these rocks may be subdivided into a northern heterolithic sequence and a southern monolithic sequence. The two sequences are shown on Figure 4. In the southern monolithic sequence, there is no compositional difference between clasts and matrix. The rocks of this uniform unit consist of ash tuff, crystal tuff, lapilli tuff, lapillistone, and less commonly tuff breccia. Along Crooked Green Creek, the felsic pyroclastic rocks display very little compositional difference. In most exposures the rocks are poorly bedded and unsorted. On large lichen-free outcrop surfaces, bedding may be defined by gradual clast-size changes on a scale of several metres. Well-defined bedding structures have been observed in sandy tuff units that are in sharp contact with massive beds of coarse fragmentals. These tuff units are, in most cases, less than a few metres wide. They show a distinct bedding layering and, in places, a grain gradation that indicates the stratigraphic top of the units.

Massive beds of monolithic lapilli tuff beds have lithic fragments that range up to a few centimetres; isolated larger fragments may be present. The matrix is tuffaceous, and shows little compositional contrast with the clasts; both are non-porphyritic. Clasts may be vesicular; the vesicles are filled with dark green chlorite. The lack of bedding and grading in these units, and their compositional uniformity, may be ascribed to either an ash flow or debris flow (lahar) origin (cf. Fisher and Schmincke 1984). The light buff

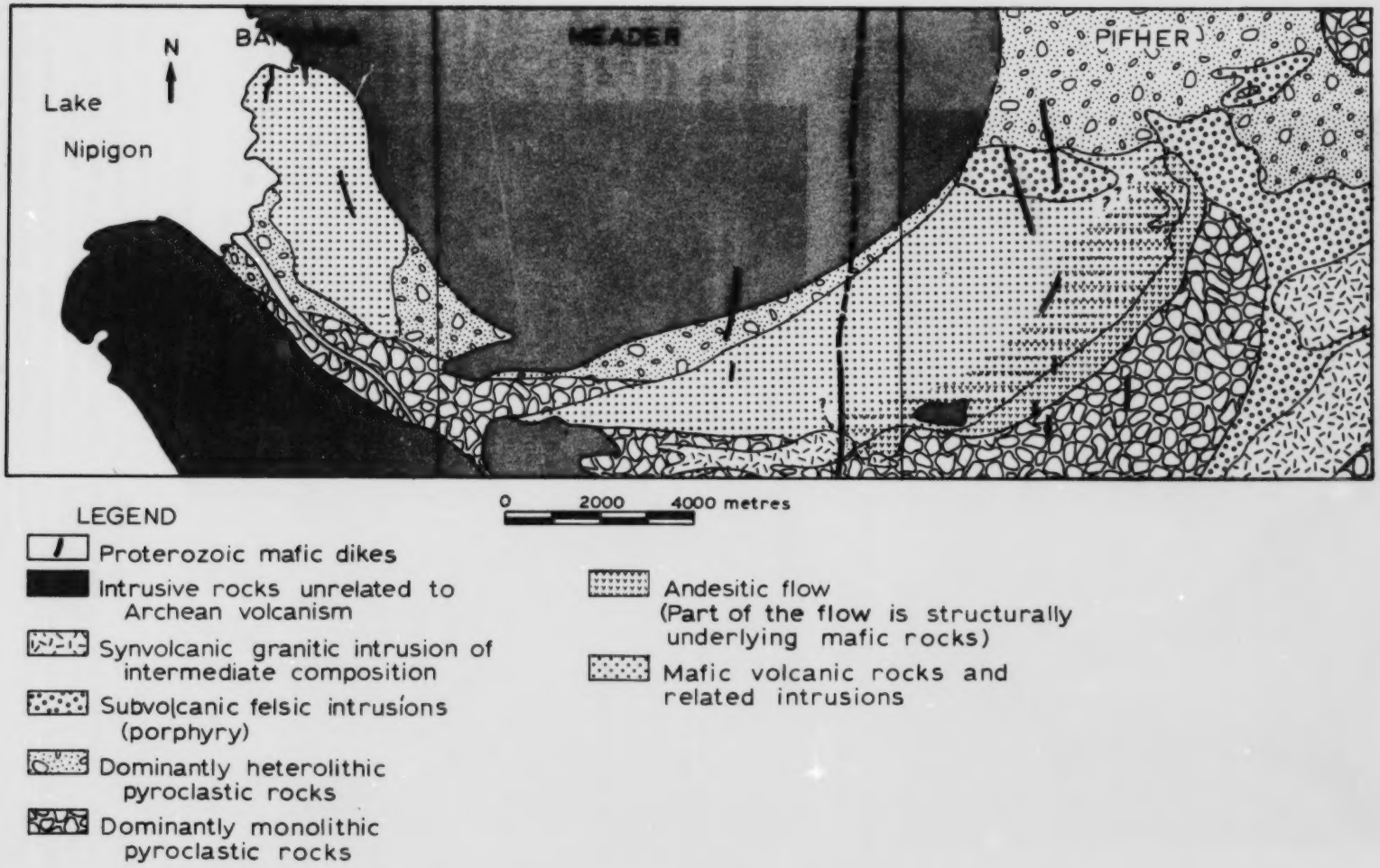

Figure 4. *Sketch map showing the areal distribution of the various Archean volcanic lithologic facies.*

Photo 6. *Fiamme in crystallophyric tuff. This rock exposure exhibits reverse size gradation of pumice (fiamme), as well as normal gradation of lithic clasts and plagioclase crystals; both indicate a southwards younging direction.*

colour of the outcrop surface, and the absence of quartz visible by the naked eye, suggests a dacitic composition.

Massive tuff units occur commonly throughout the map area. They range from fine-grained, structureless, lithic tuffs with occasional lapilli size fragments, to porphyritic tuffs which may contain up to 80 percent pyrogenic crystals. The phenocrysts are plagioclase, and less abundant amphibole. In a number of exposures, fiamme have been encountered. They occur as lenticular or wispy chlorite-rich clasts conferring a eutaxitic structure to the rock (Photo 6). The high content of chlorite in the fiamme may be attributable to seawater alteration. In several places a reverse size-gradation of fiamme, which is consistent with a southwards younging direction, has been noted. Fiamme-bearing rocks have been found only in southwestern Pifher Township and in northwestern Irwin Township. They are typical of hot ignimbrite deposits that characterize proximal (vent) volcanic environments (cf. Fisher and Schmincke 1984).

Coarse pyroclastic rocks are represented by tuff breccia and, more rarely, pyroclastic breccia. Tuff breccia deposits are normally unstratified and unsorted. Clasts generally range from lapilli to blocks of up to several tens of centimetres in diameter. Less commonly, boulders over 1 m in diameter are encountered (Photo 7). The largest volcanic clast found within the map area is a boulder over 2 m long, forming part of a heterolithic tuff breccia exposed on the shoreline of Lake Nipigon in Barbara Township. Generally, very large clasts are restricted to heterolithic deposits representing debris flows. The large fragments are massive lithic flow or lava dome material, disrupted by explosive activity. The matrix to these clasts is usually crystal tuff.

Many of the heterolithic breccias have clasts of similar composition but variable textures, including non-porphyritic dacite or andesite, and both plagioclase and plagioclase-amphibole porphyries. Porphyritic clasts are petrographically very similar to the numerous intrusive porphyries that are found throughout the south-central part of Pifher Township and which are presumably related to the volcanic rocks. Mafic clasts are relatively uncommon. In southern Pifher Township, the rocks have acquired a very strong fabric which is reflected in a strong elongation of the volcanic clasts, especially those that are highly vesicular.

In Barbara Township, the transition between the mafic and felsic volcanic rocks is a zone marked by well-stratified lithic tuffs with sedimentary structures. These structures include laminations, rhythmic compositional layering and grain size-gradation (*see* Photo 1). These tuffs represent air fall tuffs that settled through water, during the onset of felsic volcanism. Further south, coarse, heterolithic, felsic pyroclastic rocks, represented by lapilli tuff and tuff breccia, occur (Photo 8), as well as subordinate mafic pyroclastic rocks. Locally the latter have a monolithic character.

In southern Meader Township, near Musca and Pirum lakes, the volcanic rocks are mostly lithic and plagioclase-phyric tuffs, and lapilli tuff, all of dacitic composition. Further north, between the mafic assemblage and the North Wind Lake pluton, the volcanic rocks consist of tuff breccia to pyroclastic breccia. Original compositional differences between clasts

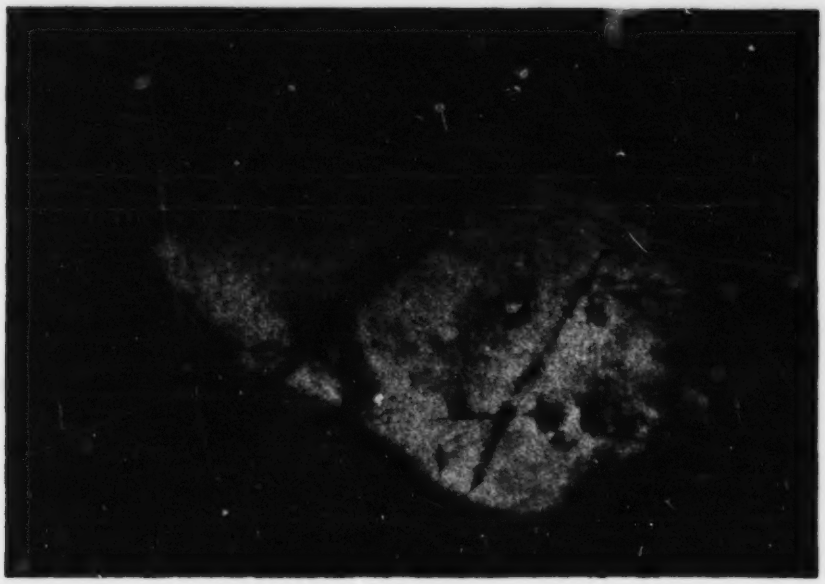

Photo 7. *A large clast in heterolithic tuff breccia. Slight differences in compositions and the extremely unsorted nature of the deposit suggest this is a debris flow produced by cvalanching of unconsolidated volcanic material. Pifher Township.*

Photo 8. *Heterolithic tuff breccia in contact with a bed of lithic tuff. The compositional range of lithic clasts is wide, with mafic, intermediate and felsic types present. Note the angular, cleavage-bedding relation in the rock. Lake Nipigon shoreline, Barbara Township.*

and matrix are difficult to recognize due to pervasive recrystallization in highly strained rocks (Photo 9, Photo 10) which has resulted in a fabric of cigar-shaped, felsic and mafic clasts set in a mafic, hornblende-rich matrix. In many places the rocks are deformed such that only a tectonic layering of alternating leucocratic and mafic bands is visible. This layering may have been produced by a combination of extreme elongation and metamorphic segregation.

In northern Pifher Township, metamorphic recrystallization has increased grain size such that coarse volcaniclastic rocks are indistinguishable from porphyry, and some heterolithic breccias have clasts

Photo 9. *Heterolithic tuff breccia showing fragments in a highly strained and recrystallized state. On lower left, a quartz vein occupies a late tension fracture. South-central Meader Township.*

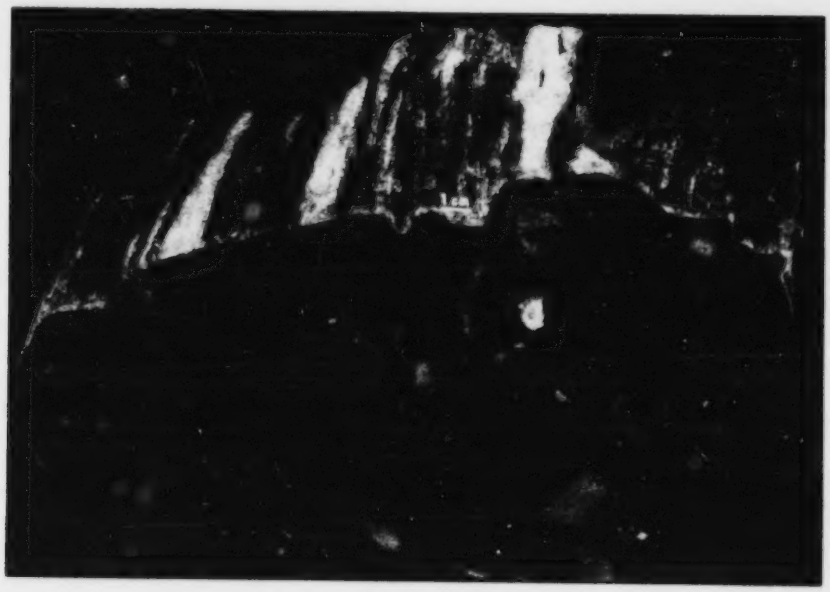

Photo 10. *Rodding of felsic clasts in a volcanic fragmental rock. The rock has been cut and polished. Tyrol Lake, Pifher Township.*

with a granitic texture that confer a conglomeratic aspect to them. The rocks in the vicinity of Pifher Lake commonly weather pink on the outcrop surface. A chemical analysis of one such rock (*see* Table 5, sample 31) clearly shows a depletion in CaO and an enrichment in the alkalis that reflect the secondary growth of albite and potassium feldspar. In thin section, the recrystallized rocks show fresh biotite and microcline. This suggests that metasomatism played an important role in the textural modification of the volcanics in northern Pifher Township.

In many places, genetic interpretation of felsic volcanics could not be made because of a lack of

identifiable primary structures. This problem was also encountered during mapping in Elmhirst Township (Mackasey and Wallace 1978).

In southeastern Pifher Township, north of the Namewaminikan River, an area underlain by massive plagioclase-amphibole porphyry was earlier considered to be a porphyritic flow (Kresz and Zayachivsky 1986). This rock is now considered to be a porphyry intrusion because of the total lack of structures which are expected to be associated with a felsic flow, such features as igneous banding, flow-top breccia and hyaloclastite, which are commonly observed in the andesite flow in central Pifher Township.

Rhyolites Rhyolites, i.e., felsic volcanic rocks with SiO_2 greater than 68 percent, are a very small part of the felsic assemblage and have been found in only four locations. The first is south of Pifher Lake, where a lens-shaped monolithic to heterolithic tuff breccia unit about 1300 m long and up to 300 m wide consists largely of quartz-feldspar porphyry clasts which are highly strained and are up to 30 cm long. A few hornblende-rich mafic clasts occur throughout this unit, indicating that the metamorphic grade is relatively high. The second is a similar rock found on the north shore of Pifher Lake.

The third is a felsic tuff unit exposed 700 m south of the northern Pifher Township boundary near Highway 801, which carries sparse quartz and plagioclase crystals with occasional mafic lithic fragments. The fourth occurrence of ryholite is quartz-eye–bearing lapilli tuff found in a few outcrops just west of Crooked Green Creek in southern Pifher Township.

A massive rhyolite with large white spherules is present in northeastern Irwin Township south of the Namewaminikan River.

EPICLASTIC ROCKS

Unequivocally sedimentary rocks have not been recognized within the map area. The only possibly epiclastic rocks would be of volcanic origin—represented by resedimented tuffs, and coarser fragmental rocks.

Intrusive Rocks

The intrusive rocks have been divided into three distinct types: 1) those which are directly related to Archean volcanism, including the mafic intrusive rocks and the intermediate and felsic porphyritic rocks; 2) pretectonic rocks of intermediate composition; and 3), syntectonic felsic rocks. Within the map area, the latter type is represented almost exclusively by a small tonalite to granodiorite batholith centred on North Wind Lake herein named the North Wind Lake pluton.

INTRUSIONS RELATED TO ARCHEAN VOLCANISM

Ultramafic Intrusive Rocks A 3 m wide, northwest-trending dike, hosted by felsic volcanic rocks, occurs on the shore of Lake Nipigon in Barbara Township. The rock is dark green, medium-grained and relatively soft. On the wave washed outcrop surface, a 30 cm wide, lighter coloured centre of the dike is surrounded by a darker periphery, suggesting the unit is a composite dike. The mineralogy of the dike consists of hornblende crystals, up to 2 mm in size, which are pseudomorphs after pyroxene; they are partially retrograded to tremolite (Photo 11). The matrix is a mixture of tremolite and chlorite. This secondary mineralogy suggests that the rock was originally composed of orthopyroxene and possibly olivine.

Mafic Intrusive Rocks Gabbro is almost entirely confined to the mafic volcanic unit. This intimate spatial relationship of the two rock types strongly suggests that the gabbroic rocks are directly related to mafic volcanism. Where associated with the mafic volcanics, gabbro is invariably melanocratic and medium- to coarse-grained, exhibiting no obvious mineralogical or textural layering.

Contacts between gabbro and massive or pillowed flows have been found in a few outcrops with vertical rock faces, in both Pifher and Meader townships. These contacts have shallow to intermediate northward dips, suggesting that the gabbro was emplaced as sills within the basaltic flows.

No chilled margins have been observed between basalt and gabbro. However, at one location on the west shore of Chellew Lake (local name), situated 500 m southwest of the Crooked Green Creek Mine No. 1 zone, an outcrop reveals a contact between gabbro and an andesite flow along which a distinct, wide chill margin has been observed. The contact is irregular and sharp, with numerous small mafic inclusions in the andesite which also appears to have been contaminated by mafic minerals.

In plan, the ratio of basalt to gabbro indicates that, volumetrically, mafic intrusions form a substantial part of the mafic assemblage; gabbro forms approximately two-thirds of the mafic assemblage in Pifher and Meader townships.

As with the basaltic rocks, the gabbro mineralogy is mostly secondary. Metamorphism of the gabbros has commonly modified primary textures, especially in areas of higher metamorphic grade such as near the North Wind Lake pluton. In greenschist facies areas, original grain size and texture are preserved; replacement of primary minerals is ubiquitous.

Most gabbroic rocks are non-porphyritic. The original pyroxene-calcic plagioclase mineralogy is now represented by actinolite to ferro-actinolite; chlorite and epidote after pyroxene; and albite, clinozoisite and quartz after plagioclase. Plagioclase crystals have commonly retained their original form but have been completely saussuritized. Magnetite

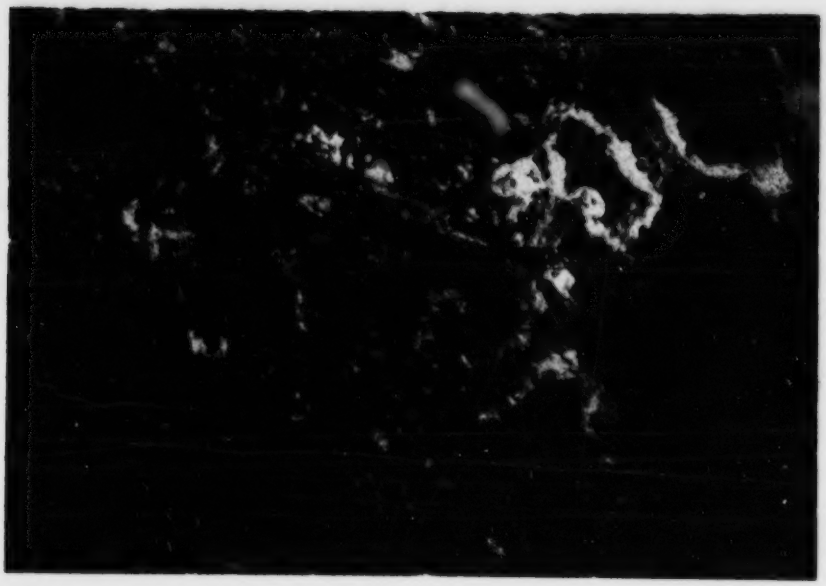

Photo 11. *Photomicrograph of an ultramafic dike rock showing hornblende (hb) crystals after orthopyroxene, partially degraded to tremolite (tm) in a tremolite-, chlorite-rich matrix. Lake Nipigon shoreline, Barbara Township. Magnification X70*

crystals have retained their habit. In some places, sulphides, mainly pyrrhotite, may constitute up to several percent of the rock. One gabbro exposure, 1500 m north of Peddle Lake in Pifher Township, carries about five percent pyrrhotite.

In amphibolite grade rocks, hornblende is the common ferromagnesian mineral, and primary plagioclase is absent.

In highly strained rocks, recrystallization blurs the distinction between gabbro and basalt. Pillow structures and amygdules found in some medium-grained rocks provide evidence that grain size alone is insufficient to distinguish extrusive from intrusive rocks, particularly near the North Wind Lake pluton.

Porphyritic gabbro has been found in three places. The most spectacular occurrence is just south of Vint Bay of Lake Nipigon. Here, a gabbro dike of uncertain dimensions, which is in contact on one side with hornblende schist, displays white plagioclase megacrysts (Photo 12). These well-defined euhedral phenocrysts range up to 5 cm in diameter. Plagioclase-phyric gabbro has also been noted 1.5 km south of Pifher Lake where a fine-grained mafic rock contains plagioclase crystals to 7 mm in size at the contact with a feldspar porphyry stock. At Pifher Lake, a 10 m wide basaltic dike that joins both arms of the lake carries sparsely distributed, white, rounded plagioclase phenocrysts up to 1 cm in size. Although the outlines of plagioclase crystals have been preserved, the phenocrysts consist entirely of saussurite.

In Barbara Township, leucocratic gabbro constitutes the southern part of an apparently stratiform body. This leucocratic gabbro is distinguished from the much more common melanocratic type by its higher plagioclase content, indicating this relatively thick intrusion is differentiated. Further south, intruded conformably into the felsic volcanic rocks, a northwest-trending gabbro intrusion has been traced for over 5000 m and has a maximum width of 250 m. This mafic intrusion is distinguished from other gabbros by its soft grey-green colour, and its very coarse, equigranular texture with individual crystals up to 15 mm in diameter. These features persist along the entire length and width of the intrusion.

Elsewhere throughout the felsic volcanic sequence, mafic intrusions are relatively few. Most are fine-grained, massive, basalt dikes up to several metres wide. One such dike, along Crooked Green Creek in southern Pifher Township, contains three, rounded monzonite clasts, the largest of which is 18 cm long (Photo 13). These xenoliths have a sharp interface with the enclosing basalt.

Lamprophyre Lamprophyre occurs as melanocratic to mesocratic dikes. The mineralogy is dominated by alkali and ferro-magnesian minerals including biotite, alkali pyroboles (primary hornblende or hornblende pseudomorphic after pyroxene), alkali feldspar and feldspathoids (Moorhouse 1959). In outcrop, lamprophyre dikes commonly stand out among other rock types through their peculiar dark colouration and weathering surfaces. Only one lamprophyre occurrence has been found within the map area. It is a 40 cm long pod within felsic volcanic rocks, 700 m southwest of Miner Lake in Pifher Township. The rock is dark grey with 25 percent, light green, 2 to 3

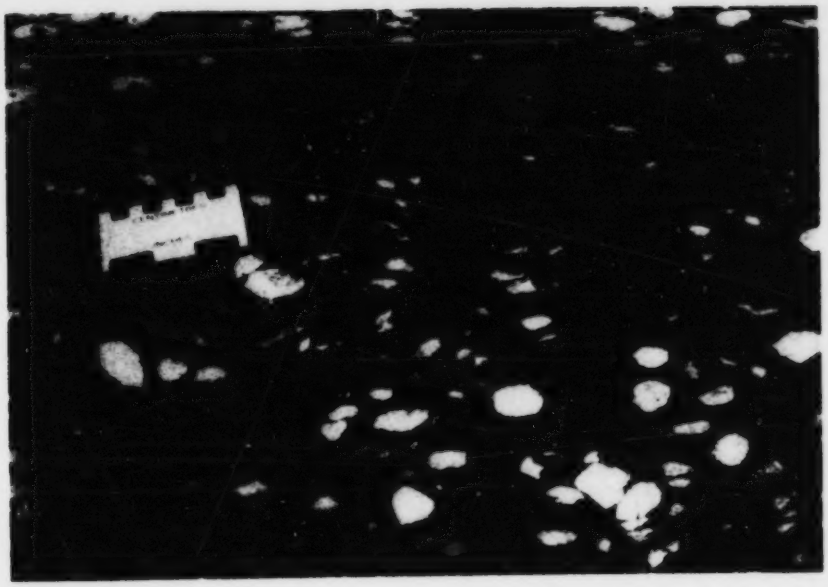

Photo 12. *Megaporphyritic texture in a foliated gabbro; the white phenocrysts are saussuritized plagioclase. Note the euhedral outline of some phenocrysts. Shore of Lake Nipigon south of Vint Bay, Barbara Township.*

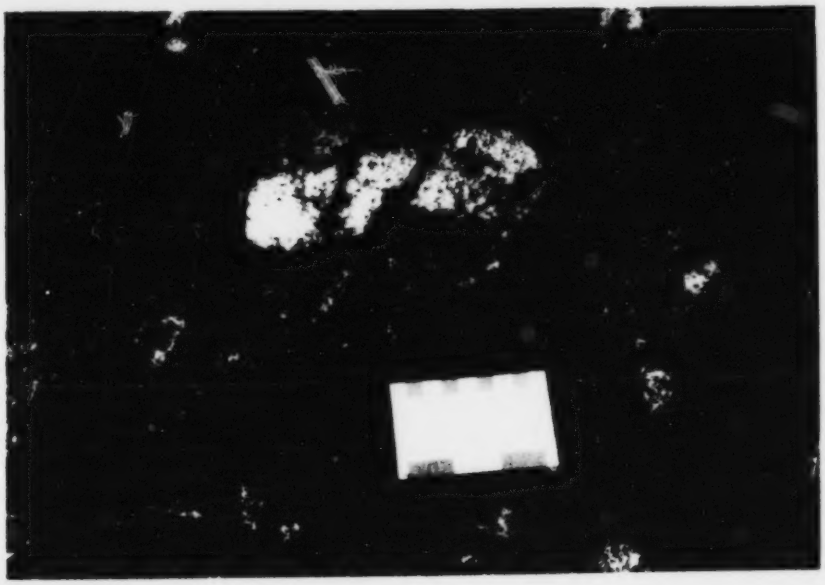

Photo 13. *Subrounded granitic clast in a basaltic dike which intrudes felsic to intermediate pyroclastics. The clast has probably been mechanically incorporated into the mafic intrusion from a subjacent granitic body. No granitic intrusion with a composition related to that of the clast (monzonite) has been found within the map area. Southern Pifher Township.*

mm diameter phenocrysts that have hexagonal cross sections on the weathered surface. Under the microscope, the phenocrysts are rounded tremolite aggregates which are pseudomorphic after orthopyroxene. The matrix is fine-grained and rich in biotite containing acicular inclusions.

Bruce (1936) reports a "large dike" having a "lamprophyric character" cutting granodiorite northeast of the Sturgeon River Mine shaft. That dike is described as containing pyroxene, magnetite, quartz, and feldspar. Mafic dikes of Archean and Protero-

zoic age observed near the old mine during the present mapping are not lamprophyres.

Felsic Subvolcanic Intrusions A wide variety of these rocks, which are mainly porphyries, were found. These porphyries have phenocrysts of plagioclase, pyroboles and quartz. The quatrzofeldspathic matrix is typically aphanitic, indicating a shallow level of emplacement. The porphyries are divided into several types, based on their phenocryst and matrix mineralogies; however, each type may comprise several sub-types.

Porphyry intrusions form dikes and irregular bodies of variable dimensions. Dikes that parallel the regional tectonic fabric have commonly been the foci of strain during shearing and have contact zones with well-developed planar fabrics. In places the entire dike has acquired a strong schistosity with preserved, rotated, quartz eyes and feldspar phenocrysts in a sericitic matrix. Individual dikes have been discontinuously traced for up to 1500 m and may be several tens of metres wide.

A large number of dikes are found in central and southern Pifher Township and in Meader Township. In northern Pifher Township, porphyry intrusions occur as dikes and stocks. Plagioclase and plagioclase-pyrobole porphyries appear to constitute a marginal phase to the quartz diorite intrusions in Pifher Township, notably the western extension of the Elmhirst Lake stock and a small stock of intermediate composition situated northwest of Miner Lake.

Major oxide and trace element abundances in both the granitic and the porphyritic phases suggest that both types are related (see Table 6, Table 7). Transitional textures between porphyritic and equigranular rock types provide further support for the notion that the marginal porphyries are related to quartz diorite plutons. This in turn leads to the suggestion that the pretectonic intrusions have been emplaced at relatively shallow levels and ultimately may be linked to the felsic volcanic rocks.

Plagioclase-Amphibole Porphyry Plagioclase- and amphibole-phyric dikes and stocks occur throughout the supracrustal rocks in Pifher and Meader townships. The plagioclase to amphibole ratio varies from three to one.

In Pifher and Meader townships, northwest-trending, plagioclase porphyry dikes with up to several percent dark green, euhedral amphibole phenocrysts cut the felsic volcanic rocks. These dikes, commonly over 20 m wide, are related to the calc-alkalic volcanic rocks, as they occur mainly within these units. Furthermore, clasts of plagioclase-amphibole porphyry similar to the dikes are common in tuff breccia. This type of porphyry also forms small stocks on the peripheries of intrusions of diorite to quartz diorite, such as the Elmhirst Lake stock and the small intrusion just north of Miner Lake. The mineralogy of the two rock types is similar, indicating a close relation between them.

In Meader Township, a deformed porphyritic body at least 3500 m long and 200 m wide is intersected by a lobe of granodiorite of the North Wind Lake pluton. The porphyry consists of a high concentration of hornblende and white plagioclase crystals which are up to 8 mm long. It is highly foliated and the mafic phenocrysts are rounded due to rotation. The plagioclase phenocrysts have been moderately to intensely replaced by white mica or by saussurite. Feldspar phenocrysts have generally retained their original form. Mafic phenocrysts consist of ferroactinolite or hornblende, depending on metamorphic grade; chlorite is common in rocks of lower metamorhic grade. The matrix consists of fine-grained feldspar, quartz, amphibole, and minor potassium feldspar.

Feldspar Porphyry Plagioclase porphyritic rocks have the same mode of occurrence as the amphibole-bearing types and are likely genetically related. Feldspar porphyry dikes which cut the felsic volcanic rocks are readily distinguishable from the amphibole-phyric dikes.

Within the felsic volcanic rocks in Pifher Township, two distinct types of feldspar porphyry dikes have been distinguished. A more leucocratic type is probably related to the amphibole-phyric dikes; the other type has fresher appearing plagioclase phenocrysts with sharper cleavage planes, and a more melanocratic matrix. The matrix mineralogy is mainly quartz and feldspar, with various amounts of amphibole and/or biotite.

Quartz-Feldspar Porphyry Quartz-feldspar porphyry occurs only in dikes cutting the volcanic rocks, except for a stock situated between Tyrol Lake and Pifher Lake; it is described separately.

Quartz porphyry dikes are equally abundant in mafic and felsic volcanic rocks. North of Peddle Lake, individual dikes have been traced for more than 1 km. The strike of the dikes is, in many cases, parallel to bedding and foliation; as a result, many dikes have a strong fabric, defined by an alignment of mica parallel to strike. The dips of most dikes have not been determined but it is assumed that they are identical to the foliation of the rocks which they intrude. Dikes are commonly several metres wide and a few are over 20 m.

The dikes consist of various amounts of quartz and plagioclase phenocrysts in a matrix of alkali feldspar (mostly albite), quartz, muscovite and rarely, biotite. Amphibole occurs as phenocrysts or in the matrix. Quartz phenocrysts commonly show embayments; in strained rocks, the quartz phenocrysts have been partially to totally recrystallized into polycrystalline aggregates. Some porphyries are quartz-phyric and lack feldspar phenocrysts. Blue quartz eyes are not uncommon, and may distinguish individual dikes. A distinct dike, at least 20 m wide, half way between

Peddle Lake and Forge Lake in Pifher Township, is characterized by 2 to 5 mm blue quartz eyes and white to orange plagioclase phenocrysts set in a fine grey matrix. One dike, about 700 m west of Peddle Lake in south-eastern Meader Township, displays strong colour banding and highly stretched phenocrysts, and contains sparse, inconspicuous, millimetre sized brown garnets. Under the microscope, these appear as rounded grains with numerous inclusions. The presence of garnet suggests alkali depletion has made the rock peraluminous; such changes in chemistry should be expected in highly strained rocks.

An elliptical porphyry stock, 3400 m by 1000 m, between Tyrol Lake and Pifher Lake is unique in the area. The stock contains several closely related gradational phases. The porphyry is typically plagioclase-phyric with phenocryst content ranging from 20 to 40 percent. Phenocrysts normally never exceed 3 mm. Millimetre to submillimetre sized blue quartz eyes occur throughout the stock but never exceed two percent of the rock. Locally, hornblende is an essential constituent. The matrix is quatrzofeldspathic with varying amounts of biotite. Under the microscope, biotites define a strong fabric which is not always obvious on the outcrop surface.

GRANITIC ROCKS OF INTERMEDIATE COMPOSITION

The Elmhirst Lake Stock

The Elmhirst Lake stock (Mackasey and Wallace 1978) occupies a portion of the southeastern quadrant of Pifher Township and extends into Elmhirst Township.

Two lobes of the intrusion in Pifher Township are separated by a narrow unit of felsic volcanic rock. Here the intrusion is a relatively homogeneous quartz diorite; tonalitic and dioritic compositions are minor. In neighbouring Elmhirst Township, the intrusion consists of granodiorite to quartz diorite (Mackasey and Wallace 1978).

The rocks are massive, medium- to coarse-grained and strongly altered. Plagioclase is commonly saussuritized although fresh grains are present. Relatively unaltered plagioclase is about An_{30}. Potassium feldspar was not present in stained slabs chosen randomly from the stock. Primary hornblende is altered to actinolite and chlorite. Primary biotite was not observed. Accessory minerals include magnetite, pyrite, apatite, zircon and titanite.

Numerous quartz veins cut the Elmhirst Lake stock in the vicinity of the Namewaminikan River. These are found in narrow northeast-trending shear zones that commonly carry sulphides and gold.

A unit of feldspar porphyry appears to form an envelope around the Elmhirst Lake stock in Pifher Township. As no distinct contact between the granitic rocks and feldspar porphyry has been found, it is believed that the granitic phase is transitional outwards into the porphyritic phase.

OTHER INTRUSIONS

Small diorite to tonalite stocks and dikes with compositions which are similar to the Elmhirst Lake stock are present in Pifher and southern Meader townships. The largest of these, in Meader Township near the southern township limit, is a body approximately 4 km long and up to 700 m wide. This body is massive, fine- to medium-grained quartz diorite. The rock consists of up to 70 percent plagioclase and up to 20 percent quartz. Various amounts of chlorite and actinolite occur after hornblende. Accessory minerals include titanite and magnetite. The intrusion is intersected by northwest-trending feldspar porphyry dikes. Shear zones mineralized with gold and copper occur along the southern margin of the stock.

A small, 300 m long, diorite intrusion occurs 1 km southeast of Tyrol Lake in Pifher Township. The rock is composed of approximately 80 percent plagioclase, 18 percent chlorite and actinolite and 2 percent quartz.

Three small bodies of diorite to quartz diorite are exposed north of Miner Lake in Pifher Township; the largest is 300 m in diameter. The unit is massive, fine- to medium-grained and composed of plagioclase with up to 10 percent quartz, up to 20 percent amphibole, and chlorite. These intrusions cut feldspar porphyry and may represent a fine-grained porphyritic phase. The porphyry contains plagioclase crystals up to 5 mm in length, with smaller subordinate crystals of hornblende.

An east-trending, quartz diorite to tonalite dike occurs south of Peddle Lake. It is up to 80 m wide, steep-dipping and has been traced in outcrop and exploration trenches for 1300 m. It is massive to locally sheared and medium-grained. It consists of plagioclase with up to 30 percent quartz, subordinate chloritized mafic minerals, accessory zircon and titanite, and secondary disseminated pyrite and carbonate.

A fine-grained, gneissic dike occurs approximately 600 m south of Tyrol Lake in Meader Township; it has been traced, in outcrop, to the southwest for 800 m.

Several small isolated outcroppings of fine-grained, massive quartz diorite occur 1 km south of Tyrol Lake in Meader Township.

FELSIC GRANITIC ROCKS

The North Wind Lake Pluton

A granitic intrusion extending from Tyrol Lake to Humboldt Bay on Lake Nipigon (Pye et al. 1966) occupies the central and northern parts of Meader Township, the northern portion of Barbara Township, and the northwestern corner of Pifher Township. The intrusion, centred about North Wind Lake, is herein named the North Wind Lake pluton. Within

the map area, the southern part of the intrusion has a crudely semi-circular shape with a maximum diameter of 10 km, measured east to west from McConnell Lake in Pifher Township to Vint Bay on Lake Nipigon. The pluton does not extend east beyond McConnell Lake as shown on earlier maps (Laird 1936; Pye et al. 1966; Stott 1984). Numerous granitic dikes extend into the supracrustal rocks from the contact, which is otherwise sharp in Meader and Pifher townships. In northern Barbara Township, the contact is marked by a large number of granitic dikes in the metavolcanics, and xenoliths in the intrusion.

Dikes of quartz-feldspar pegmatite and aplite are common along the contact, especially along Tyrol Lake and at Vint Bay on Lake Nipigon. These dikes have no preferred orientation and are generally less than 0.5 m wide.

Modal analyses, performed on 66 slabs stained for potassium feldspar, indicate mostly tonalite and granodiorite compositions, with lesser quartz diorite, quartz monzodiorite, quartz monzonite and granite, following the scheme of Streckeisen (1976) (Figure 5).

In the vicinity of Schroder Lake, Tyrol Lake and the Tyrol River, the pluton is most commonly a leucocratic granodiorite (average colour index of five) with a quartz content ranging from 15 to 30 percent and microcline, from 5 to 35 percent. Biotite is the predominant mafic mineral in the southern part of the pluton; hornblende content increases to the northwest from Tyrol Lake.

Between North Wind Lake and Lake Nipigon, modal analyses show the pluton to be mainly hornblende- and biotite-bearing tonalite and quartz diorite with a colour index of 10, based on 29 samples; quartz content ranges between 5 and 30 percent and microcline content is less than 10 percent.

Granite compositions (*sensu stricto*) are uncommon in the North Wind Lake pluton within the map area. One outcrop of porphyritic granite occurs on the south shore of Schroder Lake, 500 m east of McConnell Creek. This porphyritic granite contains microcline phenocrysts up to 1 cm long. Granite also occurs as dikes cutting biotite-hornblende tonalite at Vint Bay on Lake Nipigon.

The rocks are typically medium- to coarse-grained, equigranular and locally porphyritic. They

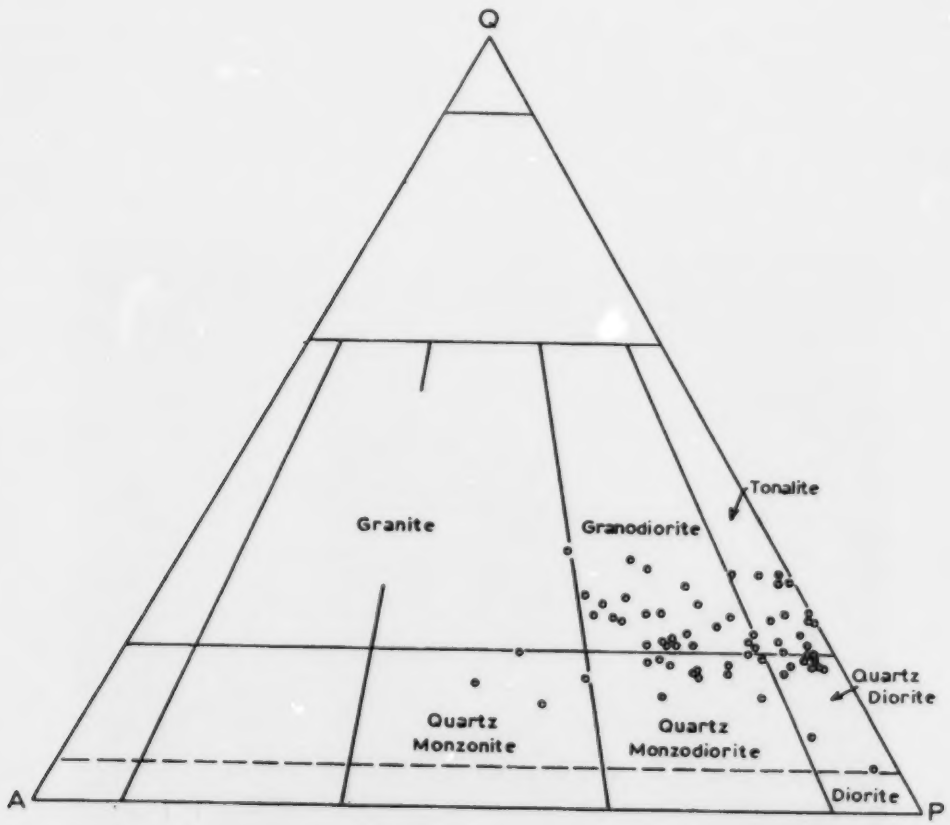

Figure 5. *Modal analyses of granitic rocks from the North Wind Lake pluton plotted on a quartz–alkali feldspar–plagioclase (Q-A-P) diagram (after Streckeisen 1976) based on a count of 300 points per sample.*

lack any fabrics, except along the southern margin of the pluton where a weak to strong foliation is present locally.

Observation of the following textural and mineralogical transitions from northwest to southeast across the pluton suggests a compositional zonation in the pluton.

1. The ratio of potassium feldspar to plagioclase increases towards the margin
2. Hornblende content decreases relative to biotite
3. The colour index decreases
4. Grain size decreases

Mafic enclaves are common between Lake Nipigon and North Wind Lake. There are two types of enclaves in the North Wind Lake pluton. The first type occurs as rounded inclusions of diorite to gabbro, to 30 cm in diameter. "Inclusion trains" of aligned diorite xenoliths are present in several outcrops at North Wind Lake and suggest an assimilation of earlier mafic rocks.

The most common type of enclave forms blocks up to several hundred metres long in the northern part of Barbara Township; a single mass, 800 m long, also occurs in hornblende-bearing quartz diorite on the northern boundary of Meader Township. These enclaves are epidotized hornblende schists derived from the mafic volcanic rocks in central Barbara Township. In the northern part of Barbara Township, the blocky enclaves become larger and more abundant towards the margin of the pluton. These are considered roof pendants produced by magmatic stoping.

VEINS

Quartz Veins

Quartz veins are found in almost every Archean rock type. They are particularly abundant in Pifher and southern Meader townships. In some areas such as to the west of Crooked Green Creek, quartz occurs in parallel, north-trending vein swarms (Photo 14). Most veins developed in tension fractures but subsequent shearing led to boudinage and folding.

In many places, severe deformation has disrupted quartz veins into irregular pods and lenses. As a result vein widths are highly variable along strike. The length of the veins is commonly a function of the extent of the associated shear zones. In southeastern Meader Township, 700 m west of Peddle Lake, a 2 to 3 m wide white quartz vein has been discontinuously traced for a distance of 500 m. On the Sturgeon River property, quartz veins have been exposed by overburden trenching over several hundreds of metres (*see* Figure 23, back pocket).

The veins generally consist of milky white to grey quartz; at the Crooked Green Creek and the Greenoaks mines the quartz is of a dark grey to morion variety. Narrow chloritic ribbons representing wall rock material are common in many veins (*see* Photo 23). A number of quartz veins are mineralized with sulphides, gold and silver. These have a significant economic importance and are described in greater detail in the economic section of this report.

Other Vein Types

On the north side of a pond 1 km north of Peddle Lake, a feldspar vein several metres wide is exposed.

Photo 14. ***Parallel quartz veins in felsic volcanic rocks. Southern Pifher Township.***

Pink microcline crystals up to several tens of centimetres wide are the only mineral constituent.

A 10 cm wide calcite vein cuts pink granitic rock on the north shore of Vint Bay in Barbara Township. Calcite is also found in subordinate quantities in quartz veins.

Quartz-dolomite veins, commonly encountered in Archean metavolcanics, have not been found within the map area.

PROTEROZOIC

Mafic Intrusive Rocks

Proterozoic intrusions comprise numerous north-trending dikes and an extensive sill at Lake Nipigon. The Proterozoic diabase dikes are distinguished from Archean mafic intrusions by their non-metamorphosed character. The diabase is usually fresh. However, exploration trenches near Peddle Lake reveal that the diabase may be weathered to a depth of 2 m or more, in areas covered by glacial overburden or thick soil.

Diabase Dikes

Two types of diabase dike are distinguished, based on the presence or absence of phenocrysts. The most common type is a non-porphyritic gabbro composed of plagioclase and clinopyroxene. The second type is represented by a single dike which is very similar to the aphyric type except for the presence of large plagioclase phenocrysts.

Porphyritic Diabase A north-trending plagioclase porphyry diabase dike has been traced discontinuously across Pifher Township. The width of the dike is consistently 30 to 60 m. Its contact with the Archean rocks, where observed, is vertical. The dike may splay, as for example 1.5 km south of Forge Lake where a 10 cm thick dikelet of aphanitic diabase with large plagioclase phenocrysts cuts Archean gabbro. Distinct chilled margins were observed.

The porphyritic diabase, locally known as "Greenspar porphyry", has been reported by Laird (1936) to be "similar in every respect" to the Matachewan diabase found in eastern Ontario. However, the latter is probably much older.

The mineralogy of the diabase consists of large subhedral plagioclase phenocrysts that may be as much as 5 cm wide (Photo 15). The phenocryst distribution is locally erratic; however, the phenocrysts are persistent along the entire length of the dike. Mackasey (1975) reported a zoning of phenocrysts, to the east of Twin Falls in Irwin Township, where they form bands parallel to the walls of the dike. On the fresh surface, the phenocrysts have a yellow-green colour due to epidote alteration. The matrix consists of medium-grained, equigranular plagioclase and clinopyroxene, with olivine in euhedral crystals altered to iddingsite and calcite. Lesser minerals include magnetite, ilmenite and pyrite. The dike extends at least 50 km south of Pifher Township.

The timing of emplacement has not been clearly established; however, petrologically, the porphyritic diabase is very similar to the nonporphyritic type described below. The phenocryst assemblage, from an

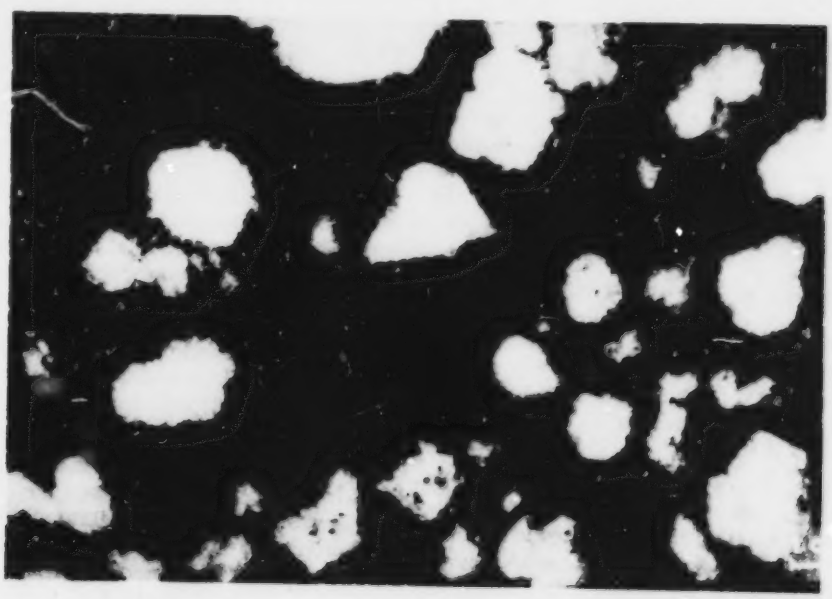

Photo 15. *Polished slab of porphyritic diabase; the large plagioclase phenocrysts have a soft yellow to light green colour. Pifher Township.*

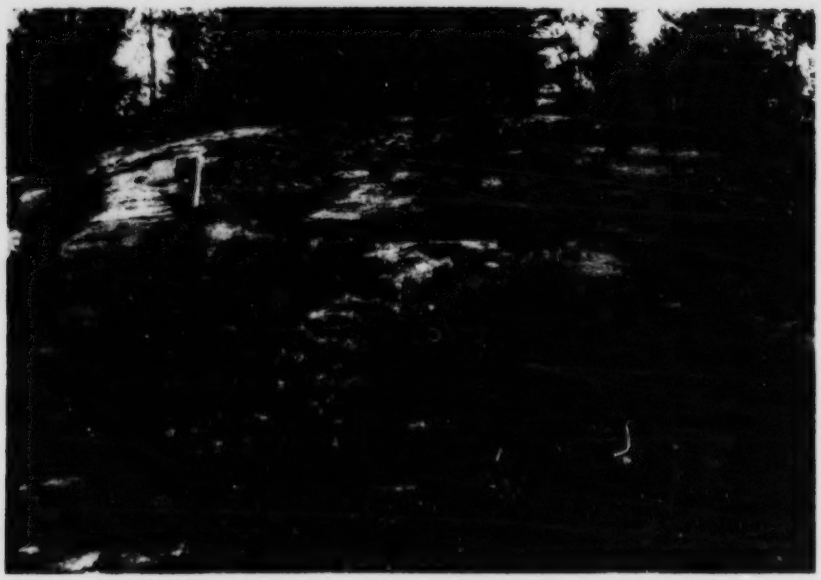

Photo 16. *Proterozoic diabase dike cutting felsic pyroclastic rocks of Archean age. The north-trending vertical dike shown on the photograph has split into three branches. Southern Pifher Township.*

aphanitic chill margin consisting of plagioclase+olivine+augite, is an assemblage identical to the one found by Sutcliffe (1986) for the chilled sill margins at Lake Nipigon. No isotopic age had been obtained from the dike, nor magnetic polarity work done, at the time of writing. Locally, the dike hosts veins of epidote which are up to 15 cm thick; some of these veins are clearly filled joints. Mackasey and Wallace (1978) also report epidote filled joints in Irwin Township. Neither type of epidote vein has been observed in the non-porphyritic diabase.

Non-Porphyritic Diabase Dikes Non-porphyritic, north-trending diabase dikes cut every type of Archean lithologic unit. In general, these dikes are vertically dipping. However, in Barbara Township, the contacts on both sides of a 17 m thick dike have the same attitude as the country rock foliation, i.e., 350°/35°E; distinct chill margins were observed.

The dikes range up to 40 m in width and commonly branch (Photo 16). Texturally they are the same as the Nipigon sills and the groundmass in the porphyritic diabase dike. Grain size is largely dependant on dike thickness, ranging from fine-grained in narrow dikes to coarse-grained in dikes over 20 m wide.

On a freshly broken surface, the rock is typically dark. The orange-brown colour on the weathered surface and the strong magnetism are diagnostic features of Keweenawan diabase dikes. All of these dikes have a common mineralogy: calcic plagioclase (labradorite), clinopyroxene, magnetite, ilmenite and olivine. The common pyroxene is augite although pigeonite is also present. Sutcliffe (1986) pointed out that the diabase dike at Vint Bay contains pigeonite as an early crystallizing phase together with augite. Olivine is present in small grains replaced by iddingsite. Magnetite and ilmenite are common in lamellar intergrowths up to several millimetres in size. According to Sutcliffe (1986), the dikes are petrographically identical to the diabase sills. On the ODM-GSC aeromagnetic maps 2129G and 2136G (ODM-GSC 1963a, 1963b), a dike at Vint Bay and one in eastern Meader Township give strong linear magnetic signatures.

Diabase Sills Part of a thick, massive diabase sill overlies the Archean rocks in southern Barbara and southwestern Meader townships. In southwestern Pifher Township, a 1 by 0.6 km outlier occurs at Peddle Lake and forms a cuesta, the top of which slopes northwards. This outlier, whose highest point is at least 60 m above Peddle Lake, consists of diabase identical to that at Lake Nipigon. On Map No. 45a, compiled by Bruce (1936) and Laird (1936), a more extensive, heart-shaped, diabase body is shown in central Pifher Township. During the course of present mapping, the rocks underlying that area have been unambiguously identified as Archean gabbro.

In most places the diabase forms prominent, steep to vertical cliffs more than 30 m high, whose base is invariably obscured by talus. Well-developed subhorizontal joints are apparent on vertical faces. On horizontal rock surfaces, two sets of vertical joints have been observed: the dominating set is east-trending with a less well developed north-trending set.

Diabase exposed in the southern part of Barbara Township is part of an extensive sill centred on Lake

Nipigon (Sutcliffe and Greenwood 1985; Sutcliffe 1986). According to Sutcliffe (1986), the sill is 140 m to 200 m thick and represents a single cooling unit emplaced at a high crustal level. From stratigraphic reconstruction, Sutcliffe (1986) estimated the overburden pressure to range between 0.06 and 0.43 kbar.

In the Mungo Park Point area of Barbara Township, pegmatitic diabase patches occur within medium-grained diabase. The patches are sharply bounded tabular bodies only a few centimetres thick and ranging in length from a few centimetres to a maximum of 2 m. The pegmatite consists of coarse-grained plagioclase, pyroxene (which may form bladed crystals up to 5 cm long), and magnetite. Sutcliffe (1986) also found graphic intergrowths of albite and quartz, fayalite and greater amounts of accessory phases such as amphibole, biotite, apatite, zircon and baddelyite than in the medium-grained diabase. The pegmatitic patches are also slightly enriched in gold, palladium and platinum (see Table 12).

The high magnetite content within the diabase induces compass needle deflection of up to 5°. The deflection is strongest at the edge of diabase units and near steep hill sides.

Phanerozoic

CENOZOIC

QUATERNARY

Pleistocene

Since the Proterozoic, the crust has been stable and has undergone a long period of erosion. During the last ice age, the Precambrian peneplain was scoured by thick continental glaciers. Glacial striations on flat bedrock surfaces indicate that the general direction of the latest ice movement was towards the southwest. In the Geraldton area, glacial striations found in protected spots show that the area was glaciated at least twice (F.J. Kristjansson, Ontario Geological Survey, personal communication, 1986).

Erosional and depositional features from the latest ice sheet have contributed to the present land forms. The abrading action of the ice resulted in rounded and polished rock exposures (*see* Photos 1, 8, 17) and a number of characteristic surface features are due to glacial erosion along linear bedrock features. Photo 17 shows a shear zone enhanced by ice scouring action.

Till is the most generally distributed surficial glacial deposit (Zoltai 1965). Within the map area, however, till is localized and thin, except where filling topographic lows. Exploration trenches at Peddle Lake and on the Sturgeon River property, and diamond-drill holes indicate a till cover seldom in excess of 1 m.

Ice crevasse fills have been found in a few places in Pifher Township; the best example is located 1.5 km southeast of Forge Lake. The other occurrences are in the northern part of Pifher Township. These ice crevasse fills are characterized by narrow, steep ridges of sandy gravel or till. Their appearance is very similar to eskers but they may be distinguished by their limited length of under 1 km.

The thicker glacial deposits, mainly represented by sand and sandy gravel of glaciofluvial origin, are concentrated in the Miner Lake area and south of Tyrol Lake (Gartner 1979). Kames form low hills or linear sandy gravel accumulations along rocky ridges. They offer an excellent source of aggregate material and a number of deposits have been quarried, mainly for road construction. In southeastern Pifher Township, a large area between the Namewaminikan River and Crooked Green Creek is covered with pebble- and boulder-free sand.

Glaciofluvial deposits are normally thicker than till deposits. Kame deposits may be up to 10 or 20 m thick. Diamond drilling along the bank of the Namewaminikan River (Carling Gold Resources Inc., Assessment Files Research Office, Ontario Geological Survey) indicates sediment thickness of 10 to 20 m.

Photo 17. *Pronounced groove carved by glacial action along a narrow shear zone trending parallel to ice flow direction. Vicinity of the Sturgeon River Mine, southeast Pifher Township.*

Glaciolacustrine deposits are nearly absent in the area. Varved clays were found during the course of the present work, on the shore of Lake Nipigon on the Barbara–Dorothea township line. According to Zoltai (1965), these clays belong to the Lake Nipigon Basin.

Holocene

After the retreat of the last ice sheet, some of the glacial deposits were undoubtedly reworked by running water, especially along spillways connecting lakes that were more extensive than at present. Recent deposits include lacustrine and fluvial clay and sand. The widespread development of swamps, marshes and bogs in low lying areas has generated organic (peat) deposits. The bottom of some lakes also have extensive accumulations of organic-rich mud (gyttja), such as at Tyrol Lake. The base of steep slopes and cliffs are commonly occupied by colluvial material.

Petrochemistry

A total of 50 samples were submitted to the Geoscience Laboratories, Ontario Geological Survey for analysis of the major and selected trace elements. Of these, 17 samples represent volcanic rocks; 29, Archean intrusive rocks; and 4, Proterozoic diabase dikes. The samples are listed and described in Table 2 and the analytical data are presented in Tables 3, 4, 5, 6, 7, and 8. Sample locations are shown on Figure 6.

The purpose of the geochemical analyses is to

1. discriminate between the various volcanic magma clans
2. describe the relationships between the volcanics and the various intrusions
3. study the effects of alteration

For genetic considerations, i.e., distinguishing between magma clans, the samples were taken from ex-

TABLE 2. SAMPLES SUBMITTED FOR CHEMICAL ANALYSIS.
Sample locations are shown on Figure 8.

Figure Number	Field Number	Rock Type (Field Description)
MAFIC TO INTERMEDIATE METAVOLCANICS		
-1A	86DUK-0100	mafic flow, massive, fine grained
-1B	-0161	mafic flow, massive, fine grained
-1C	-0172	mafic pillowed flow, fine grained
-1D	-PL01	mafic flow, albitized, fine grained
-1E	-PL02	mafic flow, albitized, fine grained
-1F	-PL37	mafic flow, albitized, fine grained
MAFIC TO ULTRAMAFIC INTRUSIONS		
-2A	86DUK-0035	mafic dike, fine grained, 3 m wide
-2B	-0110	ultramafic dike, medium grained, 3 m wide
-2C	-0114	leucogabbro, foliated, coarse grained
-2D	-0169	gabbro, mildly foliated, medium grained
-2E	-0173	gabbro, mildly foliated, medium grained
-2F	-0184	gabbro, massive, coarse grained
-2G	-1043	gabbro, massive, fine grained
INTERMEDIATE TO FELSIC METAVOLCANICS		
-3A	86DUK-0031	dacite, fine grained, flow or intrusion
-3B	-0056	dacitic clast in tuff breccia
-3C	-0058	dacitic clast in tuff breccia
-3D	-0123	dacitic clast in tuff breccia
-3E	-0127	dacitic clast in tuff breccia
-3F	-0133	felsic flow, brecciated, fine grained
-3G	-0135	felsic flow, fine grained
-3H	-0140	felsic flow, massive, fine grained
-3I	-0323	crystal tuff, homogeneous, altered
-3J	-1017	dacitic clast, tuff breccia
-3K	-1107	felsic rock, flow or dike
INTERMEDIATE TO FELSIC SUBVOLCANIC INTRUSIONS		
-4A	86DUK-0004	feldspar porphyry
-4B	-0016	feldspar porphyry
-4C	-0019	quartz-feldspar porphyry
-4D	-0027	feldspar porphyry
-4E	-0030	feldspar porphyry
-4F	-0032	feldspar porphyry
-4G	-0061	quartz-feldspar porphyry
-4H	-0128	feldspar porphyry, 3 m wide dike
-4I	-0129	feldspar-amphibole porphyry
-4J	-0132	feldspar-porphyry, 21 m wide dike
-4K	-0134	feldspar-porphyry dike
-4L	-0141	feldspar-amphibole porphyry dike
-4M	-0180	feldspar-amphibole porphyry, mildly foliated
-4N	-0205	quartz-feldspar porphyry clast in tuff breccia
-4P	-0207	quartz-feldspar porphyry, biotite-bearing
-4Q	-0212	feldspar porphyry, biotite bearing
-4R	-1004	felsite dike, fine grained
-4S	-PL05	feldspar porphyry
GRANITIC ROCKS, INTERMEDIATE COMPOSITION		
-5A	86DUK-0013	diorite, massive, fine grained
-5B	-1000	quartz diorite, massive, coarse grained
-5C	-1001	diorite, porphyritic
-5D	-PL09	quartz diorite, massive, coarse grained
PROTEROZOIC MAFIC INTRUSIVE ROCKS		
-6A	86DUK-0065	diabase, massive, medium grained, 40 m wide dike
-6B	-0068	diabase, massive, coarse grained, 30 m wide dike
-6C	-0168	diabase, massive, coarse grained
-6D	-0279	diabase, porphyritic, fine grained, 10 cm wide dike (phenocrysts excluded)

All samples analyzed at the Geoscience Laboratories, Ontario Geological Survey.

TABLE 3. MAJOR AND TRACE ELEMENT ABUNDANCES IN MAFIC VOLCANIC ROCKS OF PIFHER AND BARBARA TOWNSHIPS.
Sample locations are shown in Figure 6.

	1A	1B	1C	1D	1E	1F
SiO_2	49.8	48.0	47.6	61.3	59.7	61.9
Al_2O_3	14.5	15.1	14.0	16.3	17.4	16.4
Fe_2O_3	3.40	3.50	1.80	1.37	2.18	1.56
FeO	11.4	10.1	12.8	2.78	3.42	3.42
MgO	4.93	5.76	5.92	3.68	3.11	3.41
CaO	8.76	8.76	8.35	3.70	4.23	3.01
Na_2O	2.57	3.39	4.47	6.67	4.29	4.53
K_2O	0.36	0.22	0.15	0.29	1.37	0.85
TiO_2	1.45	1.15	1.52	0.59	0.62	0.49
P_2O_5	0.10	0.10	0.13	0.11	0.09	0.13
MnO	0.26	0.20	0.25	0.05	0.05	0.07
S	0.05	0.18	0.12	0.01	0.01	0.03
CO_2	0.17	0.19	0.13	0.12	0.15	0.21
H_2O^+	1.18	1.97	1.27	1.60	2.50	2.04
H_2O^-	0.17	0.21	0.30	0.05	0	0
Total	99.1	98.8	98.8	98.6	99.1	97.9
LOI	1.0	1.8	1.0	1.8	2.6	2.1
S.G.	2.78	3.03	3.06	2.67	2.75	2.68
Ba	100	70	60	260	380	210
Co	42	40	39	19	15	17
Cr	76	96	120	33	22	37
Cu	35	119	109	98	7	320
Ni	47	60	29	39	28	46
Pb	<10	22	<10	28	22	<10
Sc	41	39	50	14	13	16
Sr	122	170	86	126	389	269
V	352	348	429	97	99	107
Y	27	24	30	8	8	9
Zn	126	106	147	50	22	27
Zr	105	109	119	114	135	130

posures which have no apparent alteration or fabric. On an alkalies versus silica diagram (Figure 7) all rocks fall within the subalkalic field with the exception of samples 1C and 4M. These latter two samples are believed to have undergone silica depletion and sodium enrichment, which conferred an alkalic affinity.

Volcanic Rocks

Based on major element chemistry, the volcanic rocks fall into two suites distinguished on both the AFM ternary diagram (Figure 8a, Figure 8b) and a cation plot (Figure 9a, Figure 9b). The mafic volcanic rocks, which occur in the field as massive to pillowed flows, have a characteristic tholeiitic affinity and plot in the field of iron-rich tholeiites on a cation ternary diagram (Figure 9a). On the other hand, the intermediate to felsic rocks fall well within the calc-alkalic field on the AFM and cation diagrams (Figure 8b, Figure 9b) along a trend of progressive iron and magnesium depletion.

The calc-alkalic rocks are represented in the field by an extensive flow directly overlying tholeiitic basalts and gabbros, and by a thick sequence of pyroclastics. The felsic pyroclastics are heterogeneous and highly susceptible to alteration. Therefore, they have not been systematically sampled to investigate any chemical variation with stratigraphic height. Five samples from non-vesicular, aphyric clasts in monolithic tuff breccia have been taken to represent some of the pyroclastics petrochemically.

Three samples (3F, 3G, 3H) from the flow which is stratigraphically overlying the mafic tholeiitic rocks in Pifher and Meader townships, classify as andesite based on their silica content which ranges from 58.3 to 60.4 weight percent (cf. Carmichael et al. 1974). The flow, previously described as "felsic" (Kresz and Zayachivsky 1988b), also has a relatively high MgO content ranging between 3.73 and 5.33 weight percent, and an elevated chromium and nickel content which is higher than in the less evolved tholeiitic volcanics (*see* Table 5); the highest chromium and nickel values are 346 ppm and 112 ppm, respectively.

Samples 1D, 1E, 1F have been taken from bedrock exposed in exploration trenches at Peddle Lake. The obvious alteration of the rock revealed by its peculiar surface weathering colour has cast some doubt as to its original composition. Stratigraphically it ap-

TABLE 4. MAJOR AND TRACE ELEMENT ABUNDANCES IN MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS IN PIFHER, MEADER AND BARBARA TOWNSHIPS.
Sample locations are shown in Figure 6.

	2A	2B	2C	2D	2E	2F	2G
SiO_2	49.6	45.3	57.2	49.6	48.4	57.7	46.4
Al_2O_3	13.0	11.6	15.9	14.3	14.6	16.6	15.5
Fe_2O_3	3.01	1.91	2.27	3.40	1.90	1.99	2.90
FeO	10.8	8.82	4.93	9.85	11.4		
MgO	5.80	16.0	5.54	4.49	6.46	4.13	7.39
CaO	9.77	8.13	6.45	11.1	9.02	5.85	9.25
Na_2O	1.80	0.00	2.54	3.66	3.55	3.32	2.17
K_2O	0.67	1.00	1.05	0.36	0.38	1.49	0.52
TiO_2	1.29	0.66	0.76	1.18	1.22	0.64	1.01
P_2O_5	0.07	0.14	0.18	0.12	0.11	0.10	0.09
MnO	0.26	0.18	0.09	0.20	0.22	0.10	0.20
S	0.12	0.01	0.01	0.29	0.03	0.01	0.01
CO_2	0.44	0.22	0.16	0.12	0.12	0.08	0.25
H_2O^+	1.62	3.80	1.95	0.73	1.46	1.46	2.92
H_2O^-	0.20	0.20	0.15	0.23	0.22	0.26	0
Total	98.5	98.0	99.3	99.6	99.1	98.7	98.5
LOI	1.5	4.5	2.5	0.8	0.9	1.4	2.7
S.G.	3.05	2.96	2.87	3.09	3.07	3.05	2.99
Ba	200	150	243	280	110	380	170
Co	39	69	29	38	37	23	46
Cr	200	880	169	197	195	77	183
Cu	191	11	40	150	68	20	43
Ni	40	635	122	39	42	59	105
Pb	15	<10	<10	<10	<10	<10	<10
Sc	48	24	17	45	48	19	33
Sr	141	35	355	131	145	314	135
V	369	134	124	392	407	162	283
Y	25	13	10	27	26	10	21
Zn	119	97	86	112	128	77	94
Zr	102	90	146	108	114	136	99

pears to be continuous with basalts which occur north of Peddle Lake, and as a consequence, it has been mapped as altered basalt (Kresz and Zayachivsky 1988b). The immobile elements such as aluminum, titanium, chromium, zinc, yttrium, and scandium all indicate that the albitized rocks at Peddle Lake are part of the andesite flow that stratigraphically overlies the mafic assemblage. Primary structures and textures, such as flow banding and brecciation, seen elsewhere in Pifher Township are absent, having probably been obliterated by hydrothermal alteration.

The geochemistry of the felsic clasts within the pyroclastic sequence in Pifher Township is similar to that of the andesite flow but the composition is slightly more evolved, with higher SiO_2 contents and lower MgO and iron contents. Chromium and nickel values are comparable to values from the flow, with ranges of 22 to 134 ppm Cr and 26 to 88 ppm Ni.

Intrusive Rocks

The intrusive rocks have been subdivided into five major classes based on mineralogy and field relationships. These are: 1) Archean mafic to ultramafic intrusions, 2) Archean intermediate to felsic hypabyssal intrusions (porphyries), 3) Archean intermediate to felsic granitic rocks, 4) the North Wind Lake tonalite-granodiorite pluton, and 5) Proterozoic mafic dikes and sills. All intrusive types have been sampled for chemical analysis except the North Wind Lake pluton whose petrology has been studied using modal analysis (*see* Figure 5).

ARCHEAN MAFIC TO ULTRAMAFIC ROCKS

Six samples from mafic intrusions (gabbro) and one sample (2B) from an ultramafic dike have been selected for analysis. The data is presented in Table 4. Major and trace element abundances in medium- to coarse-grained melanocratic gabbro spacially associated with basalt flows (samples 2A, 2D, 2E, 2G) have identical composition to the basalts and plot on the AFM diagram in the same positions as the basalts (Figure 8a). Chromium content is higher in the gabbros, ranging from 183 to 200 ppm as compared to 76 to 120 ppm in the basalts. Sample 2C is from a leucocratic gabbro in Barbara Township, which has the chemical composition of a basaltic andesite; it is believed to be part of a differentiated intrusion. Sample 2F, from Pifher Township, shows a similar overall

TABLE 5. MAJOR AND TRACE ELEMENT ABUNDANCES IN INTERMEDIATE TO FELSIC VOLCANIC ROCKS FROM PIFHER AND MEADER TOWNSHIPS.
Sample locations are shown in Figure 6.

	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J	3K
SiO_2	62.2	60.4	62.6	64.0	62.0	60.4	58.3	58.9	61.5	59.3	59.6
Al_2O_3	16.8	17.4	17.8	16.5	15.6	15.8	16.3	16.4	16.4	16.3	17.3
Fe_2O_3	1.93	1.54	1.91	1.39	1.00	1.48	1.34	2.20	1.69	2.28	1.39
FeO	2.70	3.58	2.46	3.10	3.89	4.85	4.93	4.45	3.48	5.04	4.69
MgO	2.60	3.21	1.35	2.67	3.89	3.91	5.33	3.73	3.72	3.59	2.99
CaO	6.13	5.35	5.93	4.74	5.39	4.82	4.28	6.15	3.48	6.11	3.95
Na_2O	2.91	2.65	3.41	3.00	3.55	4.23	3.97	4.33	5.10	2.46	3.38
K_2O	1.03	1.98	0.95	1.81	1.18	1.25	0.60	0.83	1.52	1.05	1.14
TiO_2	0.55	0.62	0.70	0.69	0.60	0.54	0.47	0.63	0.49	0.56	0.64
P_2O_5	0.10	0.11	0.17	0.10	0.12	0.12	0.09	0.12	0.11	0.10	0.11
MnO	0.04	0.06	0.05	0.05	0.08	0.10	0.10	0.12	0.07	0.09	0.11
S	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CO_2	0.44	0.25	0.09	0.26	0.31	0.20	0.13	0.18	0.20	0.38	1.22
H_2O^+	1.10	1.68	1.08	1.10	1.18	2.02	2.44	1.22	1.87	2.34	2.30
H_2O^-	0.26	0	0.15	0.24	0.26	0.07	0.22	0.25	0	0	0.05
Total	98.8	98.8	98.7	99.7	99.1	99.8	98.5	99.5	99.6	99.6	98.9
LOI	2.0	2.1	1.2	1.6	1.8	1.8	2.8	1.7	1.6	2.1	3.3
S.G.	2.82	2.80	2.80	2.76	2.76	2.84	2.79	2.87	2.74	2.83	2.75
Ba	180	440	350	440	310	360	190	380	380	330	120
Co	12	18	13	15	19	22	26	20	18	24	12
Cr	71	68	22	50	154	110	346	66	184	111	60
Cu	8	50	26	28	8	22	9	24	16	22	12
Ni	49	50	26	41	88	78	112	50	60	61	46
Pb	26	23	10	<10	<10	<10	19	33	40	66	34
Sc	13	13	14	13	14	17	19	18	14	18	16
Sr	405	340	451	382	370	307	292	376	269	344	295
V	100	96	100	92	99	113	117	120	88	104	122
Y	9	10	10	8	9	10	8	10	10	13	9
Zn	46	66	45	58	60	80	76	70	55	79	18
Zr	145	147	162	151	148	140	122	134	134	152	127

composition to 2C but in the field appears as a melanocratic rock.

An ultramafic dike in Barbara Township (sample 2B) is characterized by high MgO, chromium and nickel abundances of 16 weight percent, 880 ppm and 635 ppm, respectively. On a cation diagram (Jensen 1976), this rock plots as a basaltic komatiite (*see* Figure 9a). It is strongly normative in hyperstene, enstatite and olivine.

ARCHEAN PORPHYRITIC DIKES AND STOCKS

A total of 18 samples have been selected from intermediate to felsic subvolcanic intrusions representing a wide range of rock types. The data are presented in Table 6. Based on their silica content (cf. Carmichael *et al.* 1974), the feldspar and feldspar-amphibole porphyries range from andesite to dacite, whereas quartz-feldspar porphyries have a silica content greater than 70 percent classifying them as rhyolite. On the AFM and cation diagrams (*see* Figure 8b, Figure 9b) all porphyries fall along a calc-alkalic differentiation trend.

Data for these rocks have been plotted on a normative quartz-orthoclase-plagioclase ternary diagram using Streckeisen's (1976) classification criteria for granitic rocks (Figure 10). Their position on the plot indicates that all porphyries are potassium poor.

Based on their chemical composition, the feldspar and feldspar-amphibole porphyries are indistinguishable from the calc-alkalic volcanic rocks. Sample 4R is from a felsite dike in Pifher Township that shows a peculiar composition characterized by very high alumina (22.3 weight percent Al_2O_3) and potash (4.72 weight percent K_2O) contents.

ARCHEAN GRANITIC ROCKS OF INTERMEDIATE TO FELSIC COMPOSITION

Three samples (5A, 5B, 5C) taken at the eastern margin of the Elmhirst Lake stock have been analyzed. Sample 5D is from a trondhjemite dike at Peddle Lake. The data are presented in Table 7. The three samples from the Elmhirst Lake stock show a lower content of SiO_2 and higher MgO, total iron, chromium and nickel than any of the intermediate to felsic volcanic rocks or subvolcanic intrusions. On the AFM and cation diagrams, they appear as the least differentiated rocks along the calc-alkalic trend (*see* Figure 8b, Figure 9b). The most striking chemical feature is the content of chromium and nickel which

TABLE 6. MAJOR AND TRACE ELEMENT ABUNDANCES IN SUBVOLCANIC INTRUSIONS OF INTERMEDIATE TO FELSIC COMPOSITION, FROM PIFHER AND MEADER TOWNSHIPS.
Sample locations are shown in Figure 6.

	4A	4B	4C	4D	4E	4F	4G	4H	4I
SiO_2	61.0	64.2	76.2	62.8	62.0	64.2	74.3	65.3	61.9
Al_2O_3	16.2	15.6	12.5	16.0	16.4	15.8	13.8	15.8	16.0
Fe_2O_3	2.87	2.06	0.36	1.60	1.64	1.11	0.69	1.28	1.90
FeO	3.10	3.26	0.64	3.18	3.97	2.86	0.87	2.94	3.66
MgO	2.77	2.01	0.38	2.51	2.26	2.76	0.31	1.78	1.91
CaO	6.03	5.58	1.54	5.62	5.64	5.64	1.31	4.11	7.03
Na_2O	3.55	2.76	3.58	3.45	3.47	3.46	3.55	4.22	2.94
K_2O	0.55	1.15	1.42	1.22	1.10	0.58	2.07	1.08	0.71
TiO_2	0.53	0.60	0.18	0.57	0.51	0.59	0.22	0.45	0.53
P_2O_5	0.13	0.10	0.03	0.11	0.08	0.12	0.00	0.10	0.11
MnO	0.11	0.11	0.02	0.07	0.06	0.03	0.01	0.08	0.08
S	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.03
CO_2	0.49	0.38	1.13	0.23	0.31	0.47	1.04	0.32	1.50
H_2O^+	1.46	1.22	0.50	1.13	0.88	1.24	0.35	1.70	1.76
H_2O^-	0.19	0.22	0.22	0.27	0.24	0.20	0.16	0	0
Total	99.0	99.3	98.7	98.8	98.6	99.1	98.7	99.2	100.1
LOI	2.3	1.7	1.8	1.5	1.6	1.9	1.9	1.2	3.2
S.G.	2.82	2.81	2.68	2.81	2.82	2.78	2.66	2.76	2.82
Ba	250	370	480	200	240	140	480	340	210
Co	16	13	<5	13	16	12	<5	12	16
Cr	46	52	<10	44	24	85	<10	51	45
Cu	38	22	74	50	23	7	6	34	16
Ni	37	27	<5	26	16	44	<5	29	31
Pb	32	39	30	18	24	24	40	13	<10
Sc	13	13	5	13	13	12	3	9	13
Sr	304	263	139	305	303	374	126	431	314
V	97	92	2	94	91	86	<1	66	93
Y	10	11	12	9	10	9	9	6	9
Zn	82	190	14	43	40	43	30	56	48
Zr	146	181	134	145	144	153	102	146	138

	4J	4K	4L	4M	4N	4P	4Q	4R	4S
SiO_2	62.0	63.6	60.2	47.7	69.6	65.7	64.7	66.7	64.0
Al_2O_3	15.8	15.8	16.1	15.5	16.4	16.7	17.0	22.3	17.1
Fe_2O_3	1.39	1.18	1.65	3.30	0.75	0.61	1.45	0.35	1.74
FeO	3.58	3.73	4.13	9.85	1.83	3.54	2.78	0.24	3.10
MgO	3.09	2.80	4.22	6.79	0.59	1.27	1.44	0.08	1.36
CaO	5.12	4.71	6.13	9.60	4.40	4.23	3.84	0.18	3.96
Na_2O	3.68	4.01	2.38	3.87	3.14	3.27	4.63	0.82	4.61
K_2O	1.10	0.66	1.17	0.41	0.73	2.02	0.84	4.72	0.89
TiO_2	0.48	0.47	0.60	1.01	0.58	0.44	0.53	0.74	0.58
P_2O_5	0.08	0.10	0.10	0.09	0.09	0.12	0.14	0.04	0.12
MnO	0.05	0.08	0.08	0.20	0.04	0.09	0.05	0.00	0.05
S	0.01	0.01	0.01	0.17	0.01	0.02	0.01	0.01	0.04
CO_2	0.35	0.49	0.13	0.22	0.23	0.35	0.44	0.10	0.10
H_2O^+	1.86	1.46	1.45	0.69	0.16	0.70	0.83	1.39	1.31
H_2O^-	0.05	0.06	0.20	0.30	0.28	0.28	0.23	0.21	0.05
Total	98.6	99.2	98.6	99.7	98.8	99.3	98.9	97.9	99.0
LOI	1.8	2.1	2.2	0.8	0.4	1.1	0.9	2.6	1.7
S.G.	2.81	2.78	2.86	2.84	2.70	2.74	2.72	2.76	2.74
Ba	320	310	350	80	270	430	340	480	290
Co	15	15	20	42	6	11	10	<5	12
Cr	54	79	118	169	<10	<10	12	122	14
Cu	17	36	41	91	5	27	<5	8	24
Ni	41	39	75	95	7	5	7	11	6
Pb	<10	1510	42	<10	<10	12	38	<10	<10
Sc	13	13	15	38	6	8	7	16	8
Sr	390	419	427	205	470	271	408	140	421
V	87	88	106	315	40	55	49	138	58
Y	7	8	9	21	5	9	8	10	9
Zn	50	59	67	118	38	96	56	9	25
Zr	149	149	144	97	137	146	150	157	150

TABLE 7. MAJOR AND TRACE ELEMENT ABUNDANCES IN GRANITIC ROCKS OF INTERMEDIATE COMPOSITION FROM PIFHER TOWNSHIP.

	5A	5B	5C	5D
SiO_2	57.7	56.0	55.6	74.6
Al_2O_3	17.4	16.0	15.2	12.9
Fe_2O_3	1.39	1.81	1.64	0.00
FeO	5.18	5.85	5.80	1.70
MgO	5.01	5.18	6.32	0.96
CaO	6.88	6.91	6.33	1.69
Na_2O	2.97	2.78	2.81	5.29
K_2O	0.79	0.70	0.86	0.45
TiO_2	0.56	0.71	0.60	0.32
P_2O_5	0.12	0.15	0.18	0.04
MnO	0.09	0.11	0.12	0.00
S	0.01	0.01	0.01	0.01
CO_2	0.14	0.31	0.84	0.90
H_2O^+	1.76	1.91	2.08	0.73
H_2O^-	0	0.18	0.16	0
Total	100.0	98.6	98.6	99.6
LOI	1.9	2.1	2.8	1.5
S.G.	2.85	2.87	2.83	2.66
Ba	240	230	230	200
Co	25	28	29	5
Cr	185	180	280	192
Cu	24	56	47	341
Ni	109	110	38	10
Pb	23	290	<10	28
Sc	16	19	19	54
Sr	215	251	235	140
V	95	139	131	323
Y	13	15	14	7
Zn	76	76	86	22
Zr	129	143	133	141

Sample locations are shown in Figure 6.

TABLE 8. MAJOR AND TRACE ELEMENT ABUNDANCES IN PROTEROZOIC DIABASE DIKES FROM BARBARA AND PIFHER TOWNSHIPS.

	6A	6B	6C	6D
SiO_2	49.1	50.3	49.7	49.3
Al_2O_3	14.0	13.3	14.5	14.6
Fe_2O_3	2.86	1.80	2.30	2.00
FeO	8.50	11.3	10.3	10.2
MgO	7.53	6.21	7.61	6.42
CaO	11.8	9.56	10.1	9.66
Na_2O	1.17	2.73	2.71	1.66
K_2O	0.25	0.69	0.42	0.91
TiO_2	1.10	1.38	1.12	1.29
P_2O_5	0.09	0.15	0.12	0.15
MnO	0.18	0.18	0.20	0.18
S	0.07	0.11	0.02	0.24
CO_2	0.18	0.22	0.19	0.98
H_2O^+	1.92	1.82	0.53	2.45
H_2O^-	0.26	0.19	0.28	0.12
Total	99.0	99.9	100.1	100.1
LOI	1.6	1.4	0.1	2.5
S.G.	2.99	3.04	3.04	2.94
Ba	70	250	220	330
Co	46	52	49	50
Cr	88	137	141	113
Cu	40	86	156	82
Ni	89	62	110	511
Pb	<10	<10	11	43
Sc	5	44	39	44
Sr	96	170	163	175
V	27	340	353	291
Y	16	22	22	24
Zn	92	84	116	94
Zr	67	127	107	118

Sample locations are shown in Figure 6.

is higher than in most rocks analyzed, including the mafic tholeiites.

PROTEROZOIC DIABASE DIKES

Four samples from Proterozoic diabase dikes (*see* Table 8) show a typical tholeiitic affinity (*see* Figure 8c, Figure 9c). They appear to fall within a narrow compositional range for most major elements, and for cobalt, zinc, scandium, vanadium and yttrium among the trace elements. Samples 6A and 6D are slightly quartz normative, whereas samples 6B and 6C are olivine normative.

The extensive diabase sill at Lake Nipigon has similar compositions and geochemical affinities, i.e., olivine normative to marginally quartz normative tholeiitic, to the diabase dikes (Sutcliffe 1986).

ALTERATION

Rocks showing obvious signs of alteration from petrographic observations, such as samples 1D, 1E, 1F and 3I, have chemical compositions that reflect metasomatism. Also showing signs of strong element mobility are rocks which have acquired a fabric, such as samples 1C and 4M. Table 9 lists the analysed samples which show non-equivocal element addition or removal. These changes have been predicted from petrography and by significant departure (scatter) from normative mineralogies and from expected geochemical trends as in Figure 7. There is, however, little evidence to suggest silica metasomatism in most cases, and rocks have been classified according to their silica content.

VOLCANOLOGIC IMPLICATIONS

The combination of field relations and petrochemical data allow some conclusions to be made regarding Archean volcanism in the map area.

From petrographic and petrochemical data, two distinct volcanic suites are evident: 1) a mafic tholeiitic sequence represented by massive and pillowed basalt flows and related gabbro intrusions; 2) an intermediate to felsic, calc-alkalic sequence represented by andesitic flows, andesitic to dacitic pyroclastics and related subvolcanic intrusions.

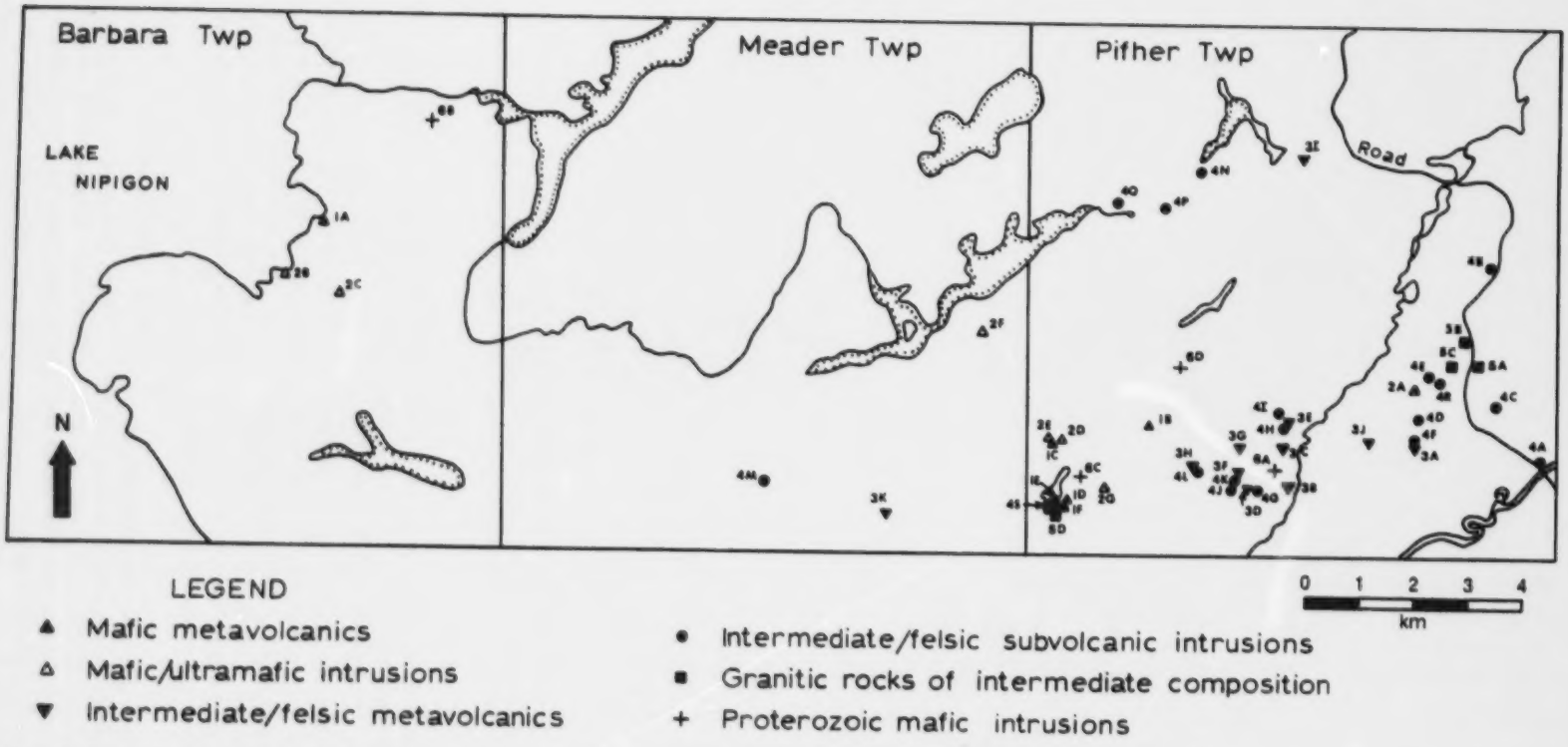

Figure 6. *Location map of rock samples submitted for geochemical analysis. Analytical results are listed in Tables 3, 4, 5, 6, 7, 8.*

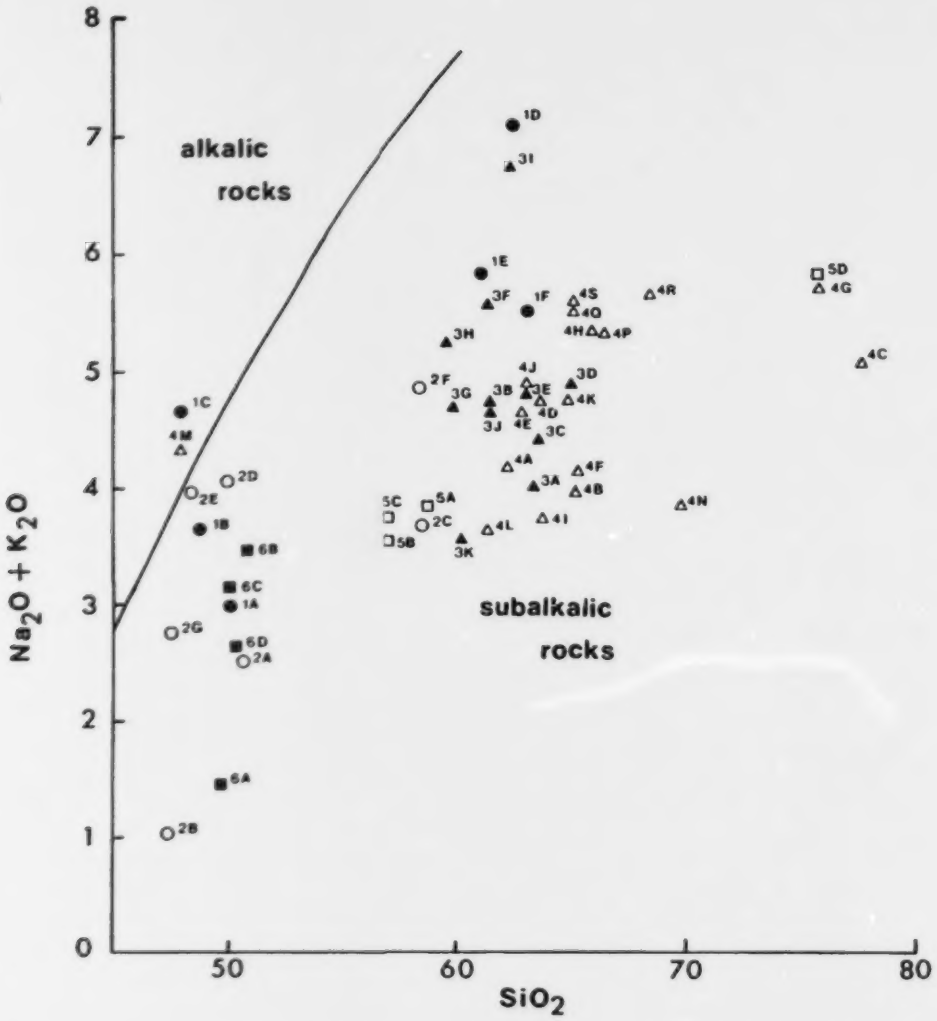

Figure 7. *Chemical classification of volcanic and intrusive rocks from Pifher, Meader and Barbara townships* (after *Irvine and Baragar 1971*). *Truly alkalic rocks, where not identified on a petrographic basis, and those rocks which fall within the alkalic field are believed to have been metasomatized. All percentages have been recalculated on an anhydrous basis.*

The higher proportion of gabbro to basalt in Pifher Township, compared to Barbara Township, suggests more proximal volcanism in Pifher Township.

Intermediate to felsic volcanics have not been sampled thoroughly for geochemistry. However, clasts in the pyroclastics show a composition slightly more evolved than the underlying andesite flow. Spherulitic rhyolite observed in northern Irwin Township suggests a progressive increase in felsic character up-stratigraphy.

From field relation, chemical characteristics and petrography, it is believed that the Elmhirst Lake stock is genetically related to the calc-alkalic volcanic rocks. This evidence includes the facts that the pluton is, at least in part, pretectonic and therefore is likely to be synvolcanic; and 2) its outer zone consists of feldspar porphyry, indicating intrusion at shallow depth.

The chemistry from three quartz diorite samples is less evolved than any of the calc-alkalic volcanic rocks and porphyries. Although on a plot of chromium versus zirconium (Figure 11) they fall in the same magma clan as the other calc-alkalic rocks, and they fall on the calc-alkalic differentiation trend (*see* Figure 8b; Figure 9b), they have lower SiO_2, higher MgO, CaO, total iron, chromium and nickel than their volcanic equivalents.

High chromium and nickel abundances in the calc-alkalic, intermediate and felsic volcanic rocks have been described from other Archean terranes by Thurston and Fryer (1983). They ascribe high concentrations in these elements to mixing of a high chro-

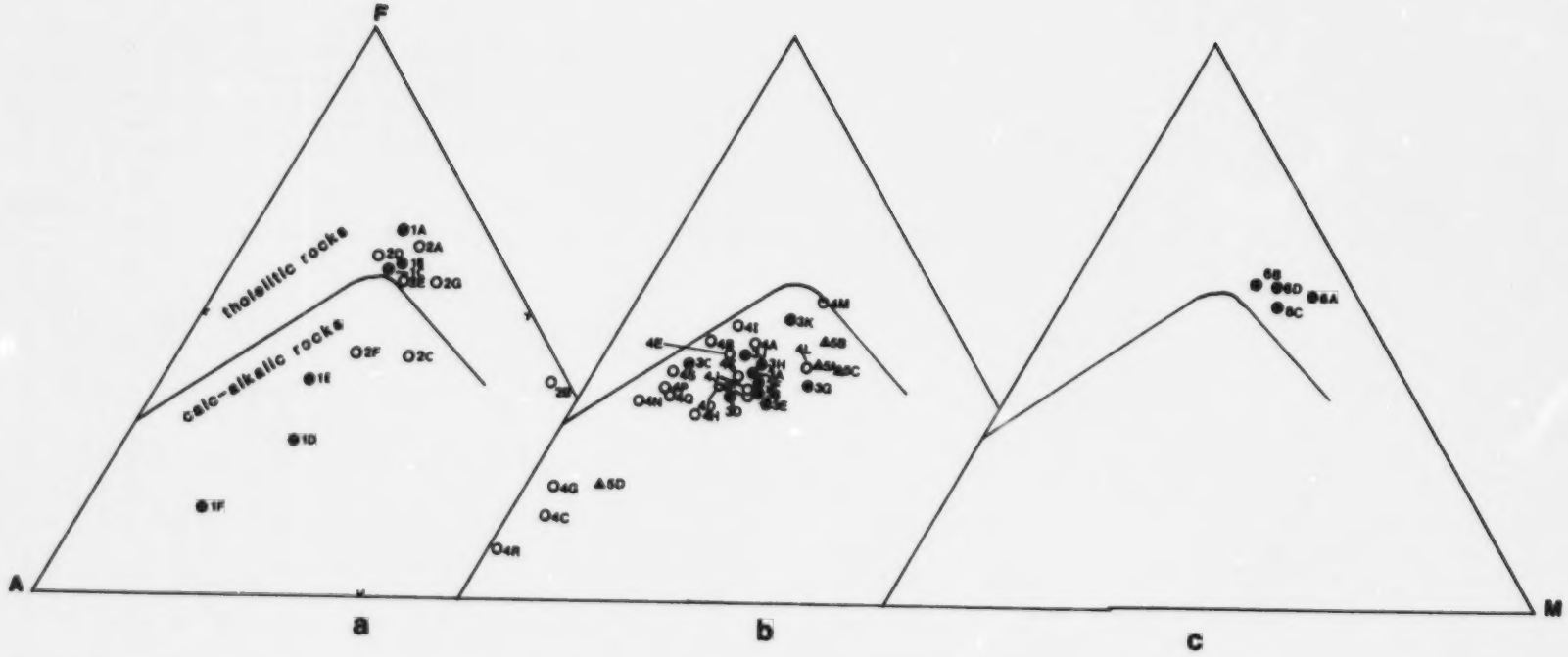

Figure 8. *Chemical classification of subalkalic volcanic and intrusive rocks of Pifher, Meader and Barbara townships* (after *Irvine and Baragar 1971*); $A = Na_2O + K_2O$, $F = FeO + 0.8948\ Fe_2O_3$, $M = MgO$.
a) *Archean mafic volcanic and intrusive rocks. Samples 1D, 1E, 1F, at first believed to represent an altered basaltic rock at Peddle Lake, have been reclassified as altered andesite on the basis of their trace element content*
b) *Archean intermediate to felsic volcanic, subvolcanic and pretectonic granitic rocks*
c) *Proterozoic diabase dikes*

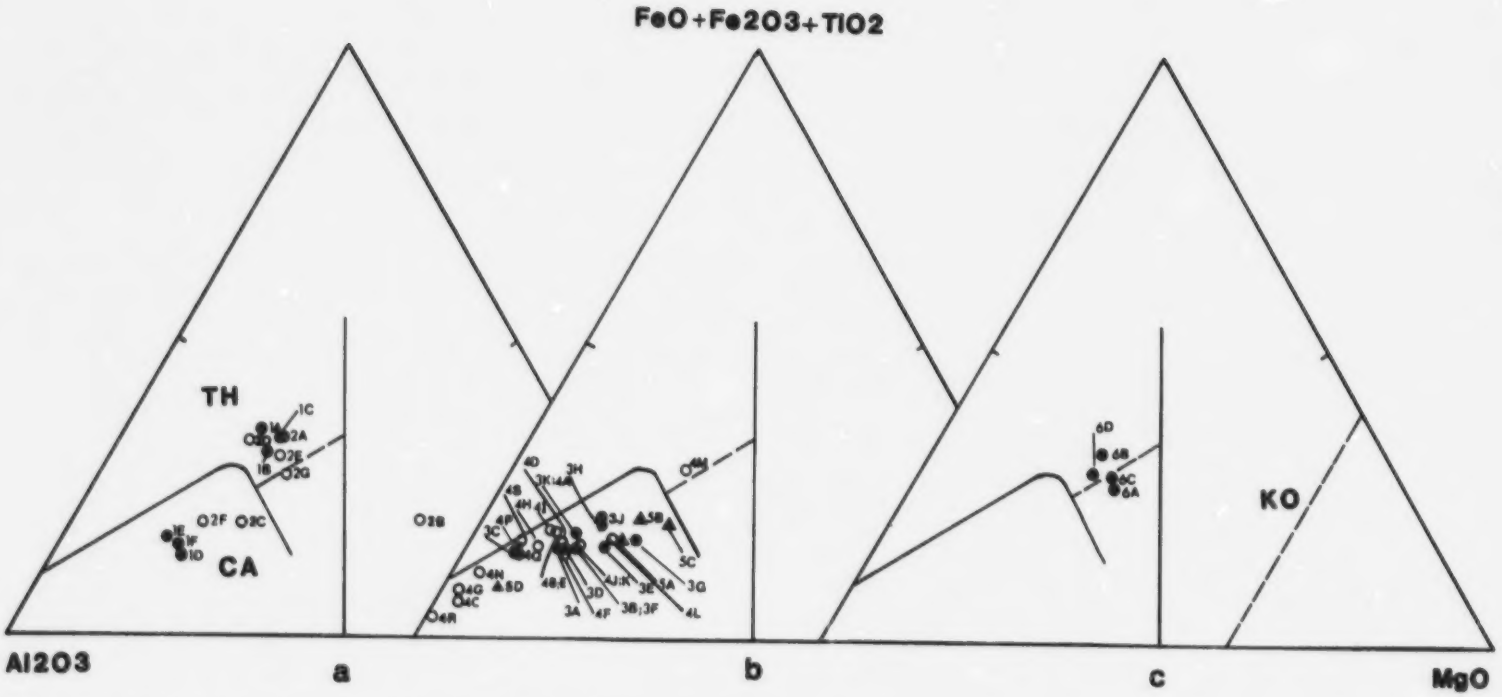

Figure 9. *Chemical classification of subalkalic volcanic and intrusive rocks from Pifher, Meader and Barbara Townships* (after *Jensen 1976*). *TH = tholeiitic field, CA = calc-alkalic field, KO = komatiitic field—this field is subdivided into the fields of komatiitic basalt (left) and ultramafic komatiite (right).*

a) *Archean mafic volcanic and intrusive rocks. Samples 1D, 1E, 1F, at first believed to represent an altered basaltic rock at Peddle Lake, have been reclassified as altered andesite on the basis of their trace element content*

b) *Archean intermediate to felsic volcanic, subvolcanic and pretectonic granitic rocks*

c) *Proterozoic diabase dikes*

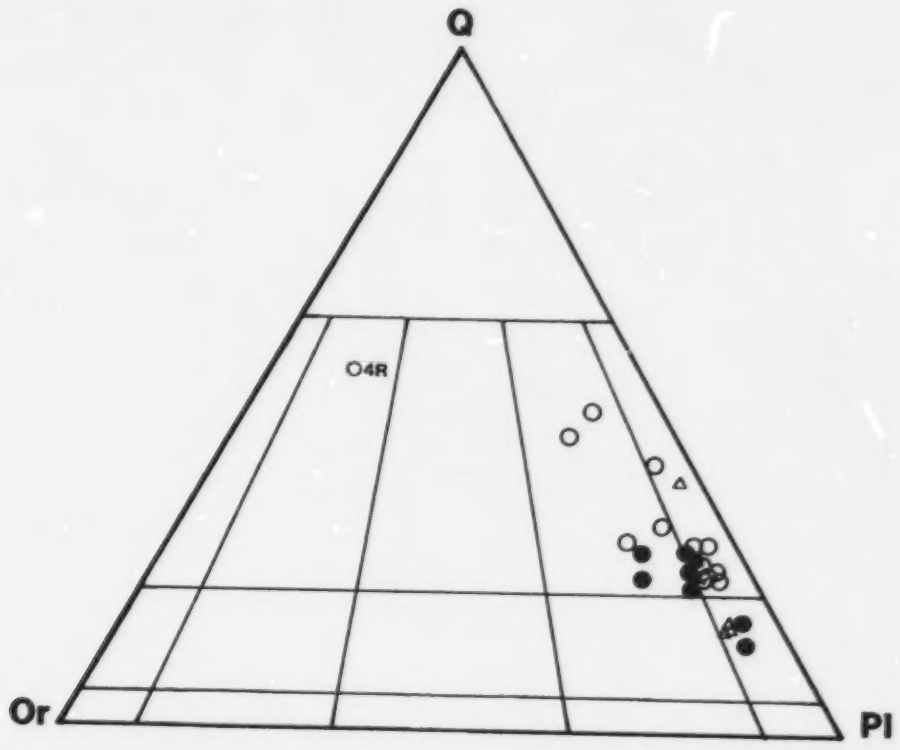

Figure 10. *Normative quartz-orthoclase-plagioclase diagram showing the position of intermediate to felsic volcanic rocks (●), subvolcanic intrusions (○), and granitic rocks of the Elmhirst Lake stock (△) (after Streckeisen 1976). See Figure 5 for nomenclature of the various fields.*

TABLE 9. ANALYSED ROCK SAMPLES WHICH SHOW SIGNS OF METASOMATISM.

Sample No	Description	Elements added	Elements removed
1C	Basalt, pillowed, slightly foliated	Na	Si
1D, 1E, 1F	Andesite; massive albitized	Na	Si, Fe, Mg, Ca Mn, Cr, Ni
3I	Crystallophyric tuff, homogeneous, pink coloured weathering surface	Na	Si
4M	Feldspar amphibole porphyry, mildly foliated	Mg, Na, Cr, Y	Si

mium-nickel tholeiitic magma with trondhjemitic liquids.

Based on variation diagrams representing chromium and yttrium versus zirconium (*see* Figure 11a, Figure 11b), it is apparent that the mafic tholeiitic assemblage and the intermediate to felsic, calc-alkalic assemblage have been derived from two separate and unrelated sources. The intermediate to felsic rocks have not been derived from the basaltic magma if olivine, plagioclase, clinopyroxene and the oxides followed the classical fractional crystallization model. It is apparent, however, that the intermediate to felsic volcanic rocks, the subvolcanic intrusions (porphyries) and the Elmhirst Lake stock are cogenetic and are related by fractionation. If the mixing model of Thurston and Fryer (1983) has indeed been the mechanism for deriving the andesites, then, owing to the high chromium and nickel concentrations in the calc-alkalic rocks, their mafic magma component must have been of a less evolved nature than the magma from which the basalts exposed within the map-area were derived.

DEPOSITIONAL ENVIRONMENT OF THE VOLCANICS

Pillow structures associated with the basalts indicate that mafic volcanism was entirely subaqueous. Increased vesicularity southwards suggests a shallowing sequence. The alternation of well-stratified lithic tuffs with vesicular pillowed basalts, at the base of the calc-alkalic sequence in Barbara Township, suggests that these rocks have been deposited in a shallow marine environment. In Pifher Township, the andesite flow shows no pillow structures, and ignimbrite units show large gas cavities up to several centimetres, implying a probable subaerial environment of deposition for the proximal, intermediate to felsic volcanic rocks.

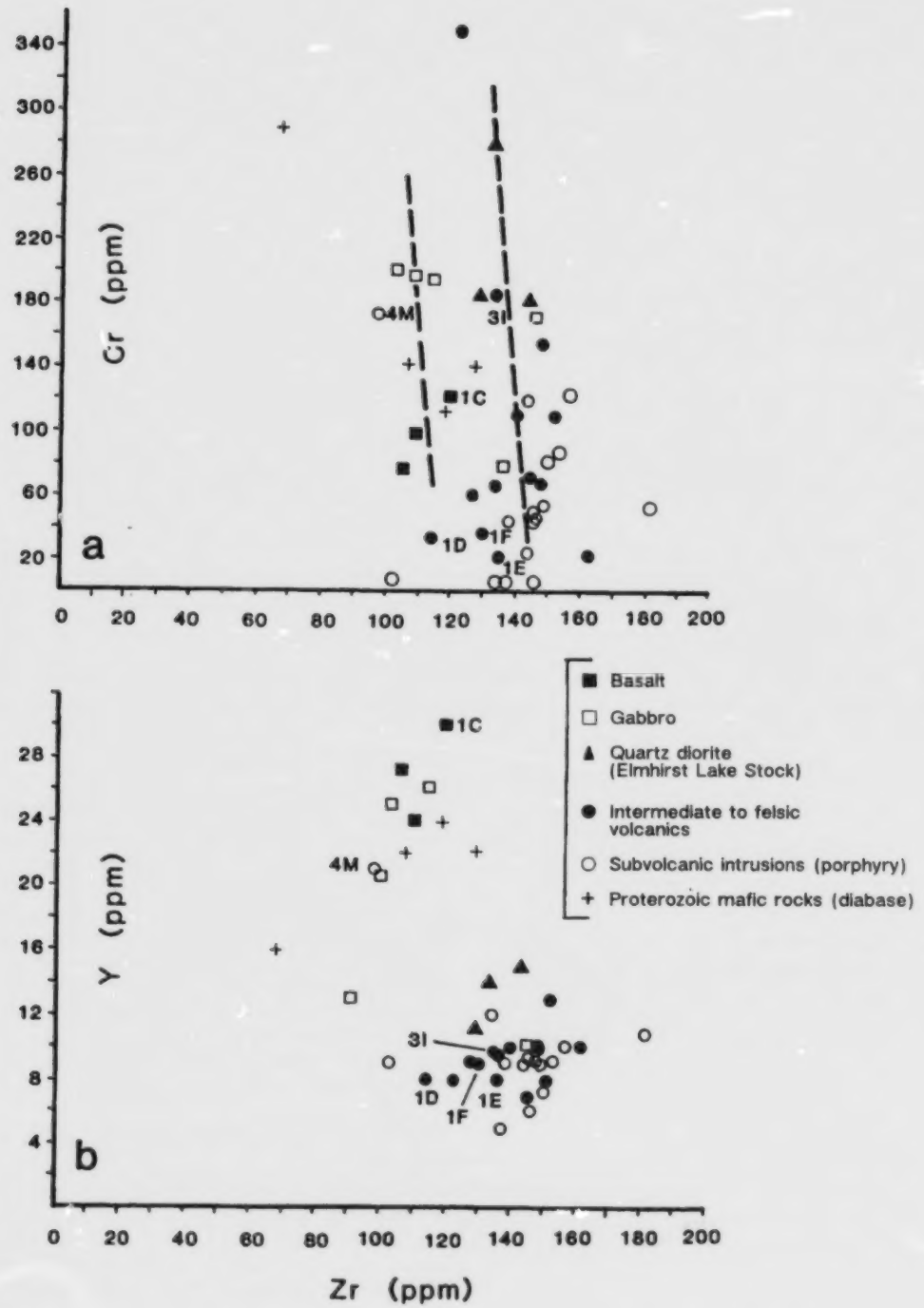

Figure 11a, b. *Cr vs Zr and Y vs Zr respectively for volcanic and intrusive rocks in Pifher, Meader and Barbara townships. The lines in the diagram a depict fractionation trends of the two magma clans. Labeled points are from metasomatized rocks* (see *Figure 7*).

Structural Geology

The map area lies in the southern part of a predominantly metavolcanic-plutonic terrane referred to as the Tashota–Onaman belt. Adjacent to the south, is the Beardmore–Geraldton metavolcanic-metasedimentary belt (Kehlenbeck 1986; Williams 1986) which is structurally dominated by prominent east-trending faults which have been characterized as ductile-brittle dextral shear zones (Williams 1986). In contrast, the Tashota–Onaman belt is characterized by large folds enhanced by the intrusion of granitic domes (cf. Schwerdtner et al. 1978).

In Barbara and Meader townships, bedding and foliations are oriented parallel to the margin of the North Wind Lake pluton, suggesting that the pluton is in part concordant to the general stratigraphy.

All supracrustal rocks have been subject to a major deformation event (D_1) characterized by a pervasive foliation and clast elongation (S_1) throughout the map area. A second deformational event (D_2) is represented by major east-trending faults, such as the Musca Lake Fault, faults and shear zones of lesser significance, and by the intrusion of the North Wind Lake pluton. Thus, secondary fabrics and structures (S_2) occur only locally and are particularly well-developed when overprinting earlier fabrics at high angles.

These deformation events have overturned the volcanic stratigraphy such that the calc-alkalic volcanic rocks, which are younger than the mafic volcanic rocks, structurally overlie them.

FAULTS AND SHEAR ZONES

Within the map area, faults are less important structural features than to the south (Mackasey 1975). Offsets of lithologic units have not been recognized from mapping, implying that if significant faults do exist, they must be parallel to stratigraphy. Ductile shear zones have been observed in numerous places along lithologic contacts, in particular where the units have a high competency contrast such as that between intrusive and volcanic rocks. Good examples of shears are found in many exploration trenches and along northwest-trending quartz-feldspar porphyry dikes in southwestern Pifher Township.

The Musca Lake Fault

The Musca Lake Fault is an east-trending structure whose surface expression is a strong lineament marked by a series of lakes and streams. The fault may be traced from northeastern Irwin Township to Little Lake in Barbara Township. The Musca Lake Fault is defined by development of strong schistosities, discrete shear zones—some of which are mineralized with sulphides and gold—and transecting fabrics in the vicinity of the topographic lineament. Near Musca Lake in Irwin Township, the fault is an electromagnetic conductor, and a zone of gouge has been intersected by diamond drilling (Mackasey 1975).

At the Twin Falls occurrence in northwestern Irwin Township, gold and pyrite mineralization is hosted by a shear zone which is several tens of metres wide, strikes 102° and dips steeply to the south (Mason and White 1986). Approximately 200 m west of the main occurrence, on the west shore of a small lake locally known as "Little Max Lake", a volcanic unit composed of lapilli tuff and tuff breccia displays spectacular intersecting foliations (Photo 18). Clast elongation is parallel to the dominant structural trend and is therefore assumed to be an earlier fabric (S_1). A secondary fabric represented by a distinct crenulation cleavage of the S_1 surface, best developed in the matrix, cuts the clast elongation at an angle of 20°. This fabric is believed to be a flattening S-fabric commonly associated with shear zones (cf. Lister and Snoke 1984; Simpson and Schmid 1983). The alignment of the volcanic clasts parallel to the shear zone may represent a rotation during deformation. Caution must be applied when interpreting such structures because the two fabrics may form simultaneously. Figure 12 shows how the fabrics observed in Photo 18 may relate to the Musca Lake Fault.

The Paint Lake Fault, approximately 3 km south of the Musca Lake Fault, is one of the most prominent structures in the general area. This major ductile-brittle dextral shear zone (Reilly and Williams 1986) marks the boundary between the Beardmore–Geraldton belt and the Tashota–Onaman terrane—two structurally distinct terranes.

The Paint Lake Fault and the Musca Lake Fault have been active for a considerable period of time as evidenced by the right lateral offset of a Proterozoic diabase dike in Irwin Township (Mackasey 1975b). The total horizontal displacement is unknown; however, mapping by Mackasey (1975) indicates that the porphyritic dike has been offset about 1.6 km along the Namewaminikan River by the Musca Lake Fault and by 0.8 km along Foxear Creek by the Paint Lake Fault. However, the measured ofiset of the dike across the entire Beardmore–Geraldton belt (Stott 1984) is about 6.5 km.

Mackasey also points out some displacement of the horizontal diabase sheet in Sandra Township. It is clear that offset of the diabase sheet is far less pronounced than offset of the porphyritic diabase dike implying an older age for the dike. In the southern part of Pifher Township, the dike shows some sinistral offsets; these are probably due to the irregular fracture pattern occupied by the dike.

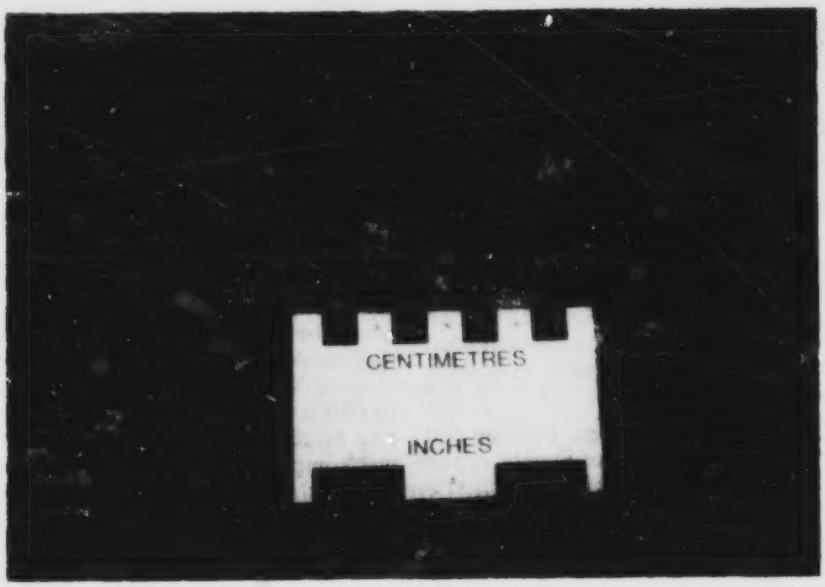

Photo 18. *Intersecting planar fabrics in tuff breccia. The fabric cutting the clast elongation is highly apparent in the mica-, chlorite-rich matrix. The intersecting cleavages define crenulation bands. Northwest Irwin Township.*

Shear Zones

Shear zones have developed in many places throughout the map area. They are defined by schist zones which display a very strong planar fabric over widths ranging up to several metres. Depending on the rock type, shear zones may be sharply bounded or their schistosity may decrease in intensity away from the central part of the shear.

Most shear zones encountered within the map area trend parallel to the general structural grain and occur along lithological boundaries such as bedding planes or intrusive contacts. These relations are well demonstrated by detailed mapping (Figure 13; *see* Figure 21, back pocket) in an area at the south end of Peddle Lake from which the overburden has been stripped. It is clear that lithologic interfaces are zones of weakness that focus strain during deformation. Good examples of sheared contacts in the map area are also displayed by northwest-trending quartz-feldspar porphyry dikes in western Pifher Township.

The sense of horizontal movement, as determined from various small scale assymetric structures, including folds, in quartz veins and S-C fabric relations (cf. Lister and Snoke 1984), is dextral in most cases. The amount of displacement cannot be determined but it is believed that a strong vertical component was present.

Shear zones within the map area are the principal structures that host mineralization and therefore are of utmost importance from an economic point of view.

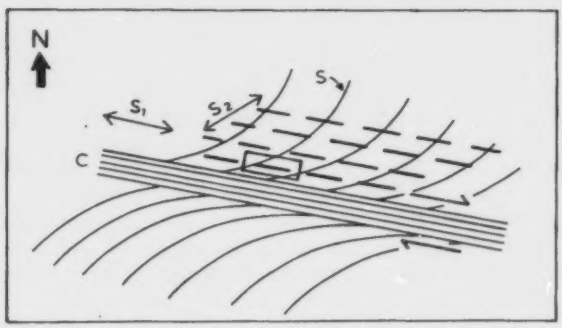

Figure 12. *Diagramatic representation of fabric relations shown on Photo 18 (rectangular box) that are associated with the Musca Lake Fault in northwestern Irwin Township. The heavy dashes depict elongated volcanic fragments that represent an earlier fabric (S_1) and which have been rotated parallel to the fault (C-surface). The surfaces may be a flattening schistosity developed during shearing.*

FOLDING

The Archean strata within the map area form a homoclinal panel. Younging structures, such as grain size gradation in tuff beds or pillow shapes in basalts, found in southern Pifher Township and on the lake shore of Lake Nipigon all indicate a south-facing sequence. However, in central Pifher Township some north-facing tuff beds indicate possible tight folding; this is further supported by the fact that near the Crooked Green Creek Mine an andesite flow exposed in a crescentic window through structurally overlying rocks, could be a surface expression of a folded structure intersected by the erosional surface. Exposures of mafic volcanic rocks surrounded by

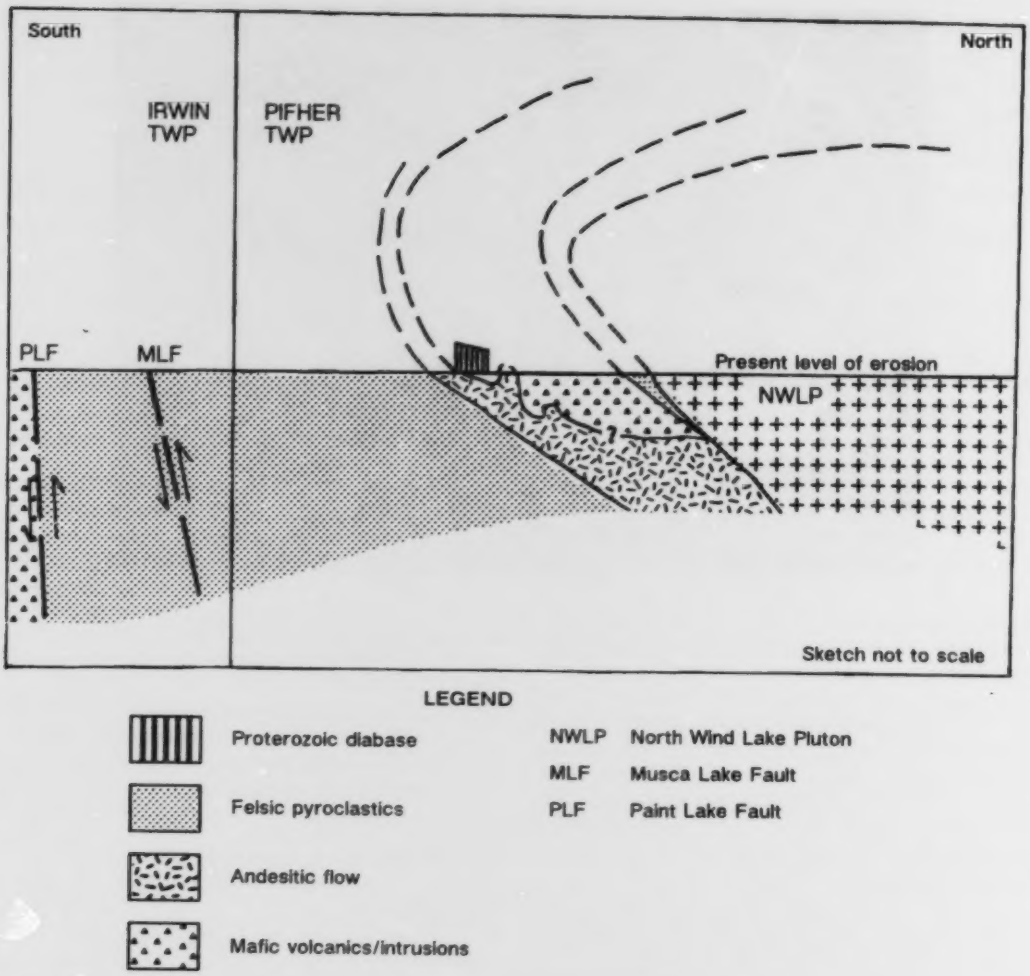

Figure 13. *Diagramatic, geological cross section along the Pifher-Meader township line.*

gabbro also show curved to crescentic outlines. The lack of facing indicators in northern Pifher Township makes it difficult to provide further support for this hypothesis.

Observed bedding surfaces all dip northwards at angles ranging from 60° to 80°, implying that the strata have been overturned. This, in conjunction with the fact that the stratigraphic layering is concentric to the outline of the North Wind Lake pluton, suggests that the pluton has intruded the volcanics, at least in part, in a conformable manner. The attitude of the pluton contact at the present erosion level is reflected in the attitude of fabric near the intrusion; the dip of foliation and the plunge of lineation are to the north at 25° to 70°. These relationships suggest that the North Wind Lake pluton is situated at the core of a major anticlinal or domal structure. Figure 13 provides an illustrational cross section through the map area.

The higher metamorphic grade in the northern part of Pifher Township also suggests that the supracrustal rocks have been uplifted relative to the rocks in the southern part of the map area. This is further supported by the fact that the mafic assemblage has been eroded away at Pifher Lake. Similarly the discontinuity in the mafic assemblage occurring in southwestern Meader Township and southeastern Barbara Township may represent an anticlinal flexure whose axis is aligned with a southwest-trending, 2 km long, granodiorite apophysis from the North Wind Lake pluton.

On a mesoscopic scale, drag-folded porphyritic dikes and boudinaged quartz veins have been observed in several places; these have been generated along shear zones.

In northern Barbara Township, hornblende schists that display a strong cleavage and metamorphic layering are commonly chevron folded (Photo

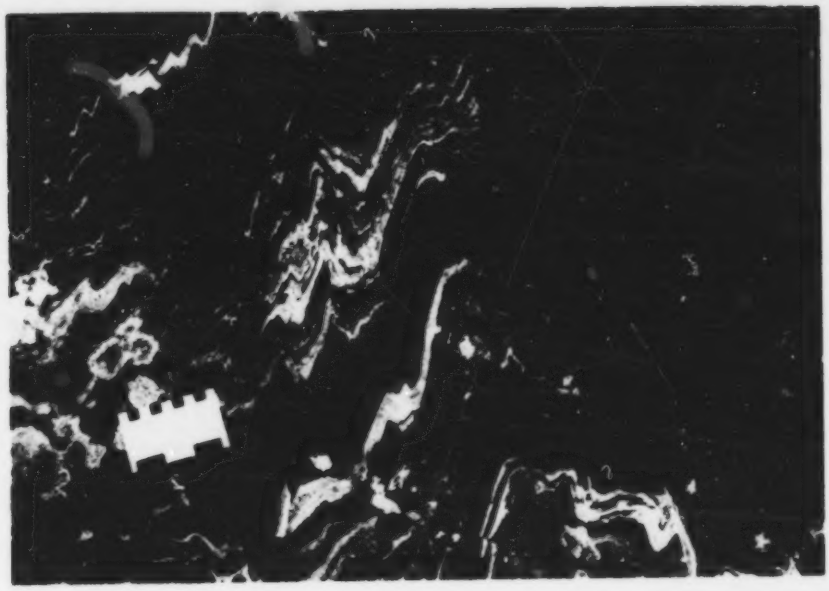

Photo 19. *Chevron folds developed in a metamorphically layered hornblende schist. The axial planes of the folds define a secondary fabric that is cutting the layering at right angles. Shoreline of Lake Nipigon south of Vint Bay, Barbara Township.*

19). The axial planes of these folds define a secondary (S_2) fabric at high angles to the original layering. These structures represent a secondary deformational event that involved local buckling of an earlier fabric by the intrusion of the North Wind Lake pluton.

TECTONIC FABRICS

All rocks within the map area, with the exception of the Proterozoic rocks, have been subjected to metamorphism and varying degrees of deformation which effects have changed the rock compositions and textures on a large scale. The resulting fabrics are defined by preferred mineral orientations, in particular of the micas, chlorites and amphiboles, and by the flattening or stretching of clasts and pillows in volcanic rocks. Fabrics are very pronounced near faults (shear zones), and near the contacts of the syntectonic North Wind Lake pluton, where they define a pronounced strain aureole. Fabrics are described in terms of foliation (planar fabrics) and lineations (linear fabrics).

Foliation

Planar fabric throughout the map area is defined by oriented minerals that confer a cleavage on the rocks, and by tectonically elongated features such as clasts and pillows. On the erosional surface, foliation appears to parallel the primary layering defined by bedding and conformable intrusions. In places, however, slight angular relationships have been noted (*see* Photo 8). In Barbara and Pifher townships, foliations trend northwest, whereas in Meader Township they trend approximately east. Dips range from 35° to vertical and are invariably northwards within the northern part of the map area. Within the southern part of the map area, dips are steep to vertical; closer to the North Wind Lake pluton they become moderate to shallow—typically 35° to 65°.

Metamorphic foliations are observed in all Archean volcanic rocks. Related intrusions, such as gabbro and porphyries, as a result of their competent nature, have in many places not been affected by penetrative fabrics. Planar fabrics have also developed in the granitic rocks along the margin of the North Wind Lake pluton in Pifher and Meader townships, but the rocks in the interior of the batholith are invariably massive. Foliation intensities increase dramatically towards the North Wind Lake pluton. In many places in Meader Township, the rocks possess a strong metamorphic banding which may be due to metamorphic segregation or, locally, to the stretching of felsic clasts.

Where two planar fabrics intersect, crenulation of the earlier fabric occurs (*see* Photo 18).

Lineations

Linear fabrics have been produced by 1) the orientation of prismatic minerals, 2) the stretching of volcanic fragments, pillows, amygdules and quartz lenses, and 3) the hinge lines of crenulations and small repetitive folds produced by intersecting planar fabrics.

A very strong mineral lineation has developed from the parallel orientation of hornblende crystals in foliated mafic rocks between Tyrol Lake and Pifher Lake.

Felsic volcanic rocks at Tyrol Lake and at Pifher Lake show a very strong rodding (*see* Photo 10) produced by the stretching of felsic clasts. Both mineral and stretch lineations trend north, with plunges that range from 30°N to 80°N.

Jointing

Variably oriented joints are common in the map area, although prominent joint sets are not widespread. The attitudes of prominent joint sets have been measured and recorded on the map. Joint measurements from the diabase sill in Barbara Township indicate three dominating joint directions: horizontal, east-trending, vertical and and north-trending.

Topographic Lineaments

Topographic linear features are shown on Maps 2536 and 2537 (back pocket) from the stereoscopic study of aerial photographs. These features are defined by linear topographic depressions commonly occupied by streams and lakes.

A large number of lineaments have been outlined in Pifher Township and in southern Meader Township. In these townships, the vast majority of lineaments trend northeast. This common trend is parallel to the direction of ice movement, and the general strike of lithological units. It is therefore inferred that many lineations reflect surface expressions of faults, shears and lithologic contacts that have been enhanced by glacial erosion. Photo 17 shows a deep groove that has been produced by glacial action along a narrow, northeast-trending shear. In Barbara Township, the trend of bedrock units is at a high angle to the direction of glacial movement and consequently the lineament density is very low.

TECTONISM AND GRANITIC INTRUSIONS

Granitic intrusions of intermediate composition, represented by the Elmhirst Lake stock in Pifher Township and a smaller stock in Meader Township, were emplaced before the main tectono-metamorphic event. Evidence for this is provided by the lack of preserved contact metamorphic aureoles around these intrusions and by the fact that the granitic rocks themselves have been metamorphosed. These intrusions are therefore considered to be syn- or postvolcanic, but are pretectonic.

The North Wind Lake pluton, a small unmetamorphosed tonalite-granodiorite batholith centred about North Wind Lake, has imposed a distinct contact aureole, that is at least 1 km wide, on the surrounding volcanic rocks. A high-strain aureole, defined by strong foliations and lineations, has also developed near the margin of the batholith. A foliation is apparent within the granodiorite, near the contact in Meader and Pifher townships. These observations suggest that the batholith has been syntectonically emplaced.

The intrusive contact of the batholith in Pifher and Meader townships is apparently sharp. In Barbara Township, the presence of a large number of mafic xenoliths within the granitic mass suggests that the batholith intruded the volcanic rocks by stoping action. This may be explained by higher fluid pressures in the magma, that led to hydro-fracturing.

ATTITUDES OF THE MAJOR LITHOLOGIC CONTACTS

The most significant contact within the map area is that between the calc-alkalic volcanic rocks and the assemblage of mafic volcanic rocks and gabbro. There are erosional windows in the mafic rocks that reveal inliers of andesitic volcanic rocks within pillowed basalt and gabbro. These windows, which are up to 1.5 km away from the main contact defined on the erosional surface, suggest that the contact dips northward at an angle which may be as shallow as 10° in the southern part of the map area. On the north side of the mafic assemblage, the contact is probably dipping in a similar way.

The contact between the North Wind Lake pluton and the volcanic rocks to the south has also been inferred from field relations to be north dipping. Metamorphic fabrics near the edge of the intrusion suggests dips on the order of 50°N at Tyrol Lake; Figure 13 illustrates this geometry.

METAMORPHISM

All Archean supracrustal rocks have been metamorphosed; however, granitic rocks of the North Wind Lake pluton are unmetamorphosed. All original mineral assemblages of the volcanic rocks, as well as their related intrusions, have retrograded to secondary mineral assemblages stable under the prevailing conditions of the Kenoran orogeny.

Mafic volcanic rocks and gabbro bear the typical mineral assemblages of low-grade metamorphism (Winkler 1979). The characteristic mineral assemblage in mafic rocks, within the map area, is quartz + tremolite-ferroactinolite + chlorite + albite + epidote-clinozoisite + calcite + titanite + white mica; this is diagnostic of greenschist-type conditions.

Around the North Wind Lake pluton is an aureole of medium-grade rocks (Winkler 1979) on the order of 2 km in width and transitional into lower grade rocks. The mineral paragenesis in the metamorphic aureole is quartz + plagioclase + hornblende + epidote ± cummingtonite ± biotite ± calcite ± titanite ± white mica. This assemblage characterizes amphibolite-type metamorphism. The presense of strong penetrative fabrics in these rocks indicates that they were metamorphosed during tectonism.

Evidence for retrograde metamorphism has been found at Peddle Lake. Overburden stripping by Peddle Lake Mining Corporation, in 1986, uncovered andesitic rocks which on surface have a distinct pink and green colouration. Thin section observations re-

veal that the pigmentation is due to alteration of albite (pink) and pumpellyite (soft green), along joint surfaces, fractures and minor veins. This has been confirmed by X-ray diffraction analysis conducted by the Geoscience Laboratories, Ontario Geological Survey. Other green minerals include actinolite and chlorite; however, these are distinguished by their dark green colour.

Thin section studies and chemical analyses (*see* Table 3, samples ID, IE, IF) point towards anomalous albite content in the andesitic rocks, which implies metasomatic introduction of sodium. Localized hydrothermal activity is believed to have caused retrograde processes that are indicated by the presence of pumpellyite. Mineral assemblages found in veins and small vugs are albite + actinolite, calcite + pumpellyite + quartz, and albite + calcite + titanite + hematite.

Metasomatic alteration has taken place at Pifher Lake, where felsic volcanic rocks contain abundant secondary silica, potassium feldspar and albite (Photo 20).

Volcanic fragmentals underlying the western part of the Sturgeon River property in Irwin and Pifher townships have been locally replaced by tourmaline, white mica and, in places, epidote (Photo 21).

A tonalitic dike at Peddle Lake has been mildly carbonatized over several tens of metres; secondary minerals show as disseminated, brown ferroan carbonate and disseminated sulphide grains.

Strong alteration is conspicuous within shear zones that acted as highly permeable channelways to hydrothermal fluids. Replacement minerals commonly include white mica, silica, carbonate, chlorite, albite, sulphides and, locally, magnetite.

The Proterozoic rocks (diabase) have not been metamorphosed.

CORRELATION BETWEEN GEOLOGY AND AEROMAGNETIC DATA

Comparison between the present mapping and aeromagnetic maps 2136G and 2129G (ODM-GSC 1963a, 1963b) indicate that the geological units which give the strongest magnetic signature are the Proterozoic mafic intrusions. Magnetic maxima correspond to the diabase sill in Barbara and Meader townships on map 2129G. A diabase outlier at Peddle Lake is expressed as a magnetic depression on Map 2136G. Two diabase dikes stand out on the magnetic maps. One such dike, exposed at Vint Bay, straddles the eastern lakeshore. Another north-trending dike occurs in eastern Meader Township.

A small cluster of closely spaced outcrops of diabase on the northern boundary of Meader Township, and several exposures in the southern part of the township, lie along a linear magnetic high that is continuous from North Wind Lake to the southeast corner of Meader Township. The strong magnetic expression from the diabase is due to the high magnetite content. The porphyritic diabase dike in Pifher Township has no magnetic expression on map 2136G, probably because of a lower content in magnetite.

The Archean supracrustal rocks are not strongly expressed and magnetic differences amongst rock

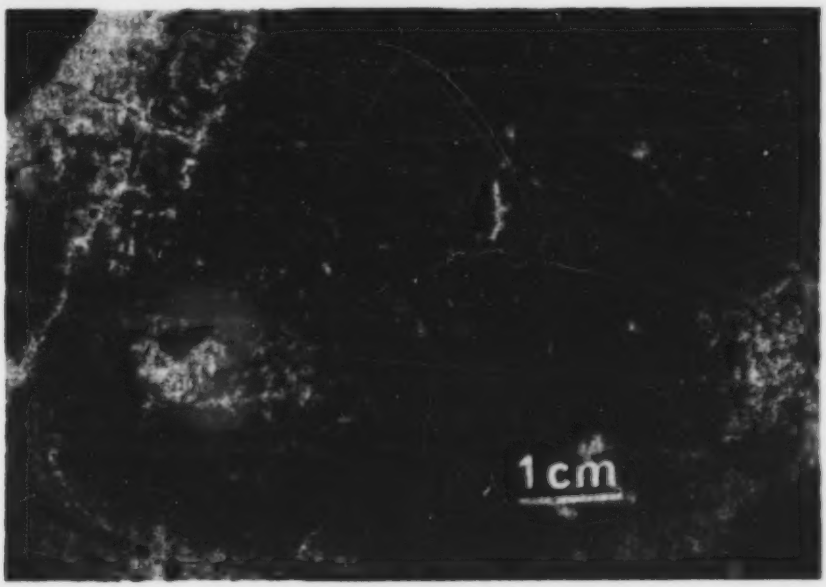

Photo 20. *Altered felsic volcanic rock in which numerous fractures filled with silica and potassium feldspar have developed. South of Pifher Lake, Pifher Township.*

Photo 21. *Rock exposure showing the effects of pervasive boron metasomatism. Black tourmaline has entirely replaced chloritic mafic clasts in a volcanic breccia. The matrix, originally of intermediate composition, has been sericitized and silicified. This exposure provides one of the most dramatic examples of metasomatic replacement in the map area. The knife is 9 cm long. Sturgeon River Gold Mine, Irwin Township.*

types are very subtle. The mafic assemblages have a higher magnetic susceptibility than the felsic volcanic rocks.

A feldspar porphyry stock with a quartz diorite core, situated just north of Miner Lake, stands out against the surrounding felsic volcanic rocks and its magnetic contour matches the outline of the intrusion on surface.

The magnetic expression of the North Wind Lake pluton is faint.

GEOCHRONOLOGY

Within the present map area, no isotopic age determinations had been carried out at the time of writing this report. One galena sample from an auriferous quartz vein hosted in a shear zone on the G. Bruce property in Southern Meader Township (latitude 49°45'14"N, longitude 087°57'46"W) has been submitted to the Geological Survey of Canada (GSC) for lead isotope analysis. Model ages of 2702 Ma and 2658 Ma, by Western Superior and Abitibi models,

TABLE 10. MODEL LEAD AGES FROM SULPHIDE MINERALIZED ZONES IN THE ONAMAN LAKE AREA AND IRWIN TOWNSHIP.

PROPERTY	MODEL AGES W SUPERIOR	MODEL AGES ABITIBI	LOCATION
Brenbar	2716 Ma	2671 Ma	Irwin Twp.
Brenbar (dup.)	2718 Ma	2674 Ma	
Cane Resources	2808 Ma	2765 Ma	49°54'N 87°42'W
Con Creek	2791 Ma	2748 Ma	49°57'30"N 087°38'45"W
Con Creek (dup.)	2796 Ma	2752 Ma	49°57'30"N 087°38'45"W
Headway	2807 Ma	2764 Ma	50°01'14"N 087°39'38"W
Headway (dup.)	2810 Ma	2768 Ma	50°01'14"N 087°39'38"W
G. Bruce Property	2702 Ma	2658 Ma	Meader Twp. 49°45'14"N 087°57'46"W
Metalore	2748 Ma	2703 Ma	Irwin Twp.
Tashota-A	2964 Ma	2921 Ma	50°14'04"N 087°40'45"W
Tashota-B	3022 Ma	2978 Ma	50°13'37"N 087°40'47"W
Tashota-C	2824 Ma	2783 Ma	50°13'30"N 087°40'36"W

Data on the Brenbar and Metalore properties from R.I. Thorpe, (personal communication, 1987). Other age determinations from Thorpe (1987).

respectively, have been obtained by R.I. Thorpe (Geological Survey of Canada, personal communication, 1987).

A U-Pb age from zircon, obtained by L. Anglin and J. Franklin of the GSC for the Headway property (Thurston 1980), which is situated about 15 km to the west of Onaman Lake, is 2769^{+6}_{-6} Ma (R.I. Thorpe, Geological Survey of Canada, personal communication, 1987). Model lead ages of 2764 Ma and 2768 Ma, using the Abitibi model, have also been obtained (Thorpe 1987); this gives an age for the mineralization which falls within the error range of the U-Pb age.

Table 10 provides further Pb-Pb isochron data for sulphide mineralization in the general area east of Lake Nipigon. The Pb-Pb ages, and the zircon U-Pb age from the Onaman area, may reflect the age of the supracrustal rocks in the Pifher Lake area because they belong to the same belt. However, the model age of 2702–2658 Ma suggests that mineralization linked to faulting, such as on the G. Bruce property in Meader Township, may have been emplaced over a long period of time.

The Proterozoic, Lake Nipigon sills have been dated using zircon and baddeleyite. Zircon fractions from two locations gave an age of 1108.8^{+4}_{-2} Ma, providing a best estimate for the intrusion of the Nipigon sills (Davis and Sutcliffe 1985). These data also provide an absolute age for the paleomagnetic reversal during which the sills were emplaced (Sutcliffe 1986). Relations between diabase dikes and the sills are not well established (Sutcliffe 1986); the similarity of their petrologies, suggests that they are related. However, Halls (1978) pointed out that some dikes have a normal magnetic polarity, which suggests a younger age for part of the diabase dike swarm.

The porphyritic diabase dike that crosses Pifher Township has not been dated nor investigated for its magnetic polarity. According to Mackasey's (1975) work, the dike underlies part of the sill along the Sandra–Irwin township boundary without intersecting it, indicating that the dike is probably older than the Nipigon sills and the non-porphyritic dike swarm.

Economic Geology

The commodity which has received the most exploration attention in the map area is gold. Exploration for gold has been fairly continuous in the area since the 1930s.

The recent surge in demand for platinum group metals (PGM) has triggered widespread interest in these throughout Ontario, including the map area.

Exploration for base metals began in the late 1940s and by the late 1970s a number of sulphide occurrences hosted by felsic metavolcanics had been investigated for their copper and zinc potential. The Pinel Creek gabbro in northwestern Elmhirst Township was intensively explored for its copper and nickel potential between 1947 and 1972.

A source of building and ornamental stone in a Proterozoic diabase dike was also investigated. Small gravel and sand deposits suitable for road building material are plentiful throughout Pifher Township and the southern part of Meader Township.

During the present survey, most of Pifher and the southern part of Meader and Barbara townships had been staked. Figure 14 shows the property boundaries in effect as of September 1986 in Pifher and Meader townships. While exploration activity in 1985-1986 was intense on ground staked over reported gold showings, little apparently took place on other properties. Table 11 presents a compilation of assessment work on file at the Beardmore–Geraldton Resident Geologist's office in Thunder Bay, and at the Assessment Files Research Office, Ontario Geological Survey, Toronto.

GOLD DEPOSITS

All known gold deposits within the map area occur in Pifher Township and southern Meader Township. Gold mineralization also occurs in the neighboring area within Irwin and Elmhirst townships. Although the mineral deposits in adjacent townships have already been described in other reports (Mackasey 1975; Mackasey and Wallace 1978), several have been mentioned again in the present report because of subsequent developments and their geological significance.

The main controls on gold mineralization within the map area are ductile shear zones and, to a lesser extent, brittle fractures, suggesting that the gold has an epigenetic origin; however, the source has not been established.

The gold deposits within the map area and its vicinity have been assigned to four distinct classes, based on the type of mineralization: 1) quartz veins in shear zones, 2) quartz veins in tension fractures, 3) shear zones with disseminated sulphide mineralization, and 4) shear zones mineralized with massive sulphide lenses and veins. The various gold deposits that have been assigned to a specific type are shown on Figure 15. All gold deposits occur in ductile shear zones or brittle fractures and therefore are of epigenetic origin.

Large scale exploration for gold began in the general Sturgeon River area after the discovery, in 1934, of a small but spectacular occurrence on what became the Maloney Sturgeon property. The Sturgeon River deposit, discovered in 1934, was put into production in 1936 and a total of 73 439 ounces of gold and 15 922 ounces of silver were recovered from 1936 through 1942.

In the 1980s, a widespread staking rush was triggered by a combination of high gold prices, the delineation of a significant gold deposit on the Brookbank prospect in central Irwin Township by Metalore Resources Limited (*The Northern Miner*, March 24, 1986), and the discovery of a new gold occurrence north of Twin Falls in northwestern Irwin Township. A number of new occurrences were brought to light. Past discoveries were re-evaluated by extensive overburden stripping, diamond drilling, and further exploration work. Between 1980 and 1984, 1455 tons of ore were recovered from the Crooked Green Creek Mine; some mining was also carried out at the Greenoaks prospect in 1982 and 1986.

GOLD IN SHEAR ZONE HOSTED QUARTZ VEINS

All deposits related to quartz veins in shear zones within the map area are at lithologic contacts, where the rocks are more susceptible to ductile deformation and fracturing.

Gold bearing quartz veins within ductile shear zones are well represented on the Sturgeon River property (*see* Figure 23, back pocket), the Brenbar Mine in Irwin Township (Mackasey 1975), the Maloney Sturgeon prospect and in southern Meader Township (*see* Figure 15). In the field, this deposit type consists of single veins which may be followed for considerable distances, such as at the Sturgeon River property (*see* Figure 23, back pocket).

Ductile shear zones within felsic volcanic rocks and within felsic to intermediate intrusions have been well exposed by recent overburden stripping on the Sturgeon River property. Northeast-trending shears are steeply dipping to vertical and range in thickness from a few centimetres to several metres (Photo 22). Development of boudinage structures in the veins causes variation in thickness, from a few centimetres to over 1 m (Photo 23). Veins have been observed to pinch out over distances of up to several tens of metres, where the shear zone narrows. The contact between the veins and the wall rock is sharp. Veins commonly have a ribboned character imparted by very thin chlorite- and sericite-rich bands representing host rock material. These bands may become

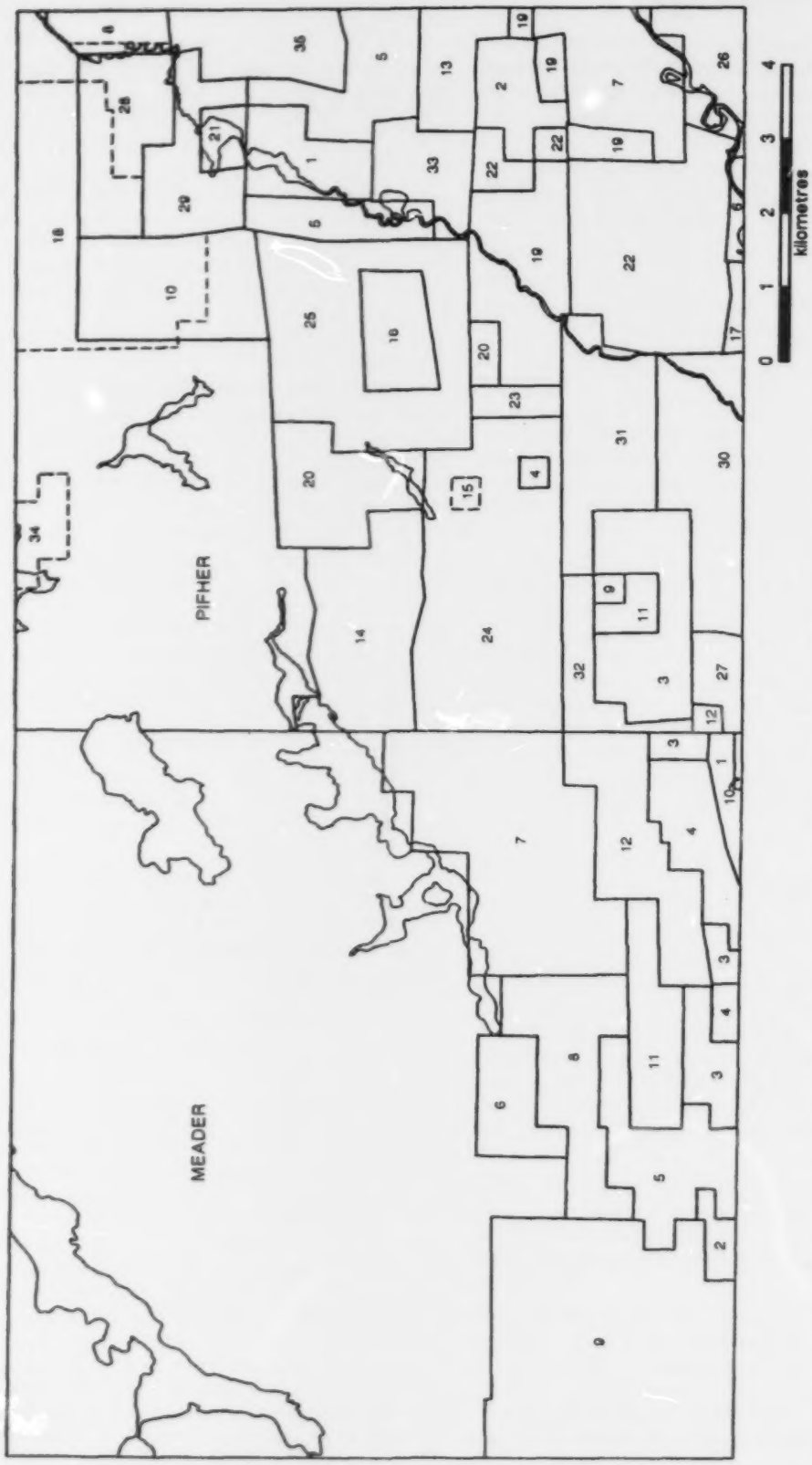

Figure 14. *Sketch map of properties held in Pifher and Meader townships as of September 1986; see Table 11 for property names.*

TABLE 11. INFORMATION ON PROPERTIES IN PIFHER AND MEADER TOWNSHIPS ON FILE WITH THE ASSESSMENT FILES RESEARCH OFFICE (AFRO), ONTARIO GEOLOGICAL SURVEY AND THE BEARDMORE-GERALDTON RESIDENT GEOLOGIST'S OFFICE, AS OF DECEMBER 31, 1986.

PIFHER TOWNSHIP

Map Number	Property Holder	AFRO File	Year	Commodity Sought	Type of Work
1	Auger, T.	Tyrol Lake 22	1960		DD
		2.9393	1986		AM, AEM
2	Augmitto Explorations Ltd.	Tyrol Lake 31	1972–73	Au, Ag, Cu	DD
		63.3133	1973		IP, GM
		63.3460	1972	Cu	T
		2.6066	1983	Au, Ag, Cu	GM, GEM
3	Baarts, A.	Tyrol Lake 20	1959	Au	DD
		Tyrol Lake 27	1969–70		DD
		2.1643	1974		IP
		2.1926	1975		GM
		2.6090	1983	Au, Ag	G
		2.9476	1986		AEM, AM
4	Betcherman, P.				
5	Brenbar Mines Limited				
6	Bruce, G				
7	Carling Gold Resources Inc.	63.1087	1960	Cu	GEM
		Res.*	1960	Au, Ag, Cu	DD
		Tyrol Lake 23	1961		DD
		2.610	1971		IP, GEM
		Tyrol Lake 30	1971–72		DD
		Tyrol Lake 36	1984	Au	DD
		Tyrol Lake 38	1985	Au, Ag	DD
		2.8823	1985	Au, Ag	DD
8	Chemalloy Minerals Ltd. (1971)	63.406	1953		ER, GM
		63.3128	1971	Mo	DD
9	Cowan, M.F.	2.1926	1975		GM
		2.6090	1983	Au, Ag	G
		2.9299	1986	Au	GC
10	Cox, L.	Tyrol Lake 26	1966		DD
		2.796	1972		GEM, GM
		2.1155	1972	Cu, Zn, Ni, Ag	G, GC
11	Cox, N., Huston, C., Lassila, P., Thorsteinson, D.	2.1926	1975		GM
		2.6090	1983	Au, Ag	G
12	Cox, N., Lassila, P., Thorsteinson, D.	Tyrol Lake 20	1959	Au	DD
		Tyrol Lake 32	1973	Cu	DD
		2.1643	1974		IP
		Res.*	1985		T
		2.9393	1986		AM, AEM
13	Enders, C.	63.3133	1973		IP, GM
14	Gray, J.J.	63A.34	1949	Au	G
		63.803	1956		GM, GEM
		Tyrol Lake 16	1957–60		DD
15	Greenspar Mines Ltd.	Res.*	1965	Building stone	T
16	Hillsborough Exploration Ltd.	Tyrol Lake 17	1947	Au	DD
		Tyrol Lake 22	1960	Au	DD
		Res.*	1967		IP, ER, GM
		2.4846	1982	Au, Ag, Cu	G
		Tyrol Lake 35	1983	Au, Ag, Cu	DD
		2.8695	1985	Au, Ag, Cu	GC
		Tyrol Lake 39	1986	Au, Ag, Cu	DD
17	Hopkins, A.P.				

TABLE 11. Continued.

PIFHER TOWNSHIP

Map Number	Property Holder	AFRO File	Year	Commodity Sought	Type of Work
18	Labrador Exploration (Ontario) Ltd. (1973)	2.796	1972		GM, GEM
		2.1155	1972	Cu, Zn, Ni, Ag	G, GC
19	Maruska, E.	Tyrol Lake 19	1959		DD
		2.1266	1972		IP
		2.5836	1983	Au	G
		2.7249	1984		GM
		2.9470	1986		AM, AEM
20	Mealey, P.	2.5836	1983	Au	G
		2.7249	1984		GM
21	Miron, W.	2.5234	1982		GEM
22	Mitto, A.	2.669	1971		AM, AEM
		2.1054	1971		GM
		2.1266	1972		IP
		63.3460	1972	Cu	T
		2.6066	1983	Au, Ag, Cu	GM, GEM
		63.4335	1985		T
		2.9470	1986		AM, AEM
23	Nabigon, J.	2.5836	1983	Au	G
		2.7249	1984		GM
24	Nabigon, J. and Nabigon, A.R.				
25	Northern Concentrators Ltd.	Tyrol Lake 18	1958		DD
		Tyrol Lake 22	1960	Au	DD
		Res.*	1967		IP, ER, GM
		63.2982	1972		T
		2.5251	1980	Au, Cu	GEM
		Tyrol Lake 35	1983	Au, Ag, Cu	DD
		2.5722	1983		GM, GEM
		2.5756	1983		G
		2.6435	1983	Au, Ag, Cu	T, GC
		63.4304	1983	Au, Ag, Cu	GM, GEM, DD
		2.8453	1985	Au, Ag, Cu	DD, GC
		Tyrol Lake 37	1985	Au, Ag, Cu	DD
		2.9514	1986	Au	GC
26	Phoenix Gold Mines Ltd.	63.3052	1972	Au, Ag, Cu, Zn	GM, GEM, T, GC
27	Podany Mining Corp.				
28	Rosenblatt, A.	Tyrol Lake 11	1947	Au	DD
		Tyrol Lake 26	1966		DD
		2.796	1972		GM, GEM
		2.1155	1972	Cu, Zn, Ni, Ag	G, GC
		Res.*	1977		T
29	Sheridan, J.P.	63.406	1953		GM, ER
		Tyrol Lake 33	1965		DD
		Tyrol Lake 28	1969		DD
		Res.*	1977		T
		2.5234	1982		GEM
		Tyrol Lake 34	1983	Au, Ag, Cu	DD
		63.4314	1983	Ag, Cu	DD
30	Skalesky, P. (Atlantic Mining Corp. option)	2.669	1971		AM, AEM
		2.1054	1971		GM
		2.1926	1975		GM
		2.8752			AM, AEM

TABLE 11. Continued.

Map Number	Property Holder	AFRO File	Year	Commodity Sought	Type of Work
PIFHER TOWNSHIP					
31	Skalesky, P. (Peddle Lake Mining Corp. option)	2.669	1971		AM, AEM
		2.1054	1971		GM
		2.5836	1983	Au	G
		2.7249	1984		GM
		2.9476	1986		AM, AEM
32	Ternowesky, J.	2.9476	1986		AM, AEM
33	Thorsteinson, D.	2.9393	1986		AM, AEM
34	Wenzoski, J. (1976)	Res.*	1976		T
35	487219 Ontario Ltd.	Tyrol Lake 10	1947		DD
		Tyrol Lake 12	1953		DD
		63.390	1953		GM, ER
MEADER TOWNSHIP					
1	Baarts, A.	2.9476	1986		AM, AEM
2	Bernier, P.	2.9393	1986		AM, AEM
3	Bruce, G. (Sweany Gold Corp. option)	63.3858	1963		G
		Res.*	1971		T
		2.9393	1986		AM
4	Holmwood Resources Ltd.	Tyrol Lake 14	1954		DD
		Tyrol Lake 15	1954	Cu	DD
		63.1250	1963		SP
		63.3858	1963		G
		Tyrol Lake 24	1964–68		DD
		Tyrol Lake 25	1966		DD
		Res.*	1966	Au, Ag, Cu	GEM, S.P., DD
		Tyrol Lake 29	1970		DD
		Res.*	1973		T
		2.7086	1984		GM, GEM
		Meader Twp. 10	1984		DD
		Meader Twp. 11	1985		DD
		Meader Twp. 12	1985		DD
		Meader Twp. 13	1985		DD
5	Houghton, F.	2.9393	1986		AM, AEM
6	MacAdam, R.				
7	Nabigon, A.				
8	Nabigon, J.				
9	Peplinski, M.				
10	Podany Mining Corp.				
11	Skalesky, P.	2.9476	1986		AM, AEM
12	Ternowesky, J.	Tyrol Lake 15	1954	Cu	DD
		2.9476	1986		AM, AEM

Res.—Beardmore-Geraldton Resident Geologist's files*

Abbreviations:

AEM -airborne electromagnetic survey
AM -airborne magnetometer survey
DD -diamond drilling
ER -resistivity survey
G -geological survey
GC -geochemical rock survey
GEM -ground electromagnetic survey
GM -ground magnetic survey
IP -induced polarization survey
SP -self potential survey
T -stripping, trenching

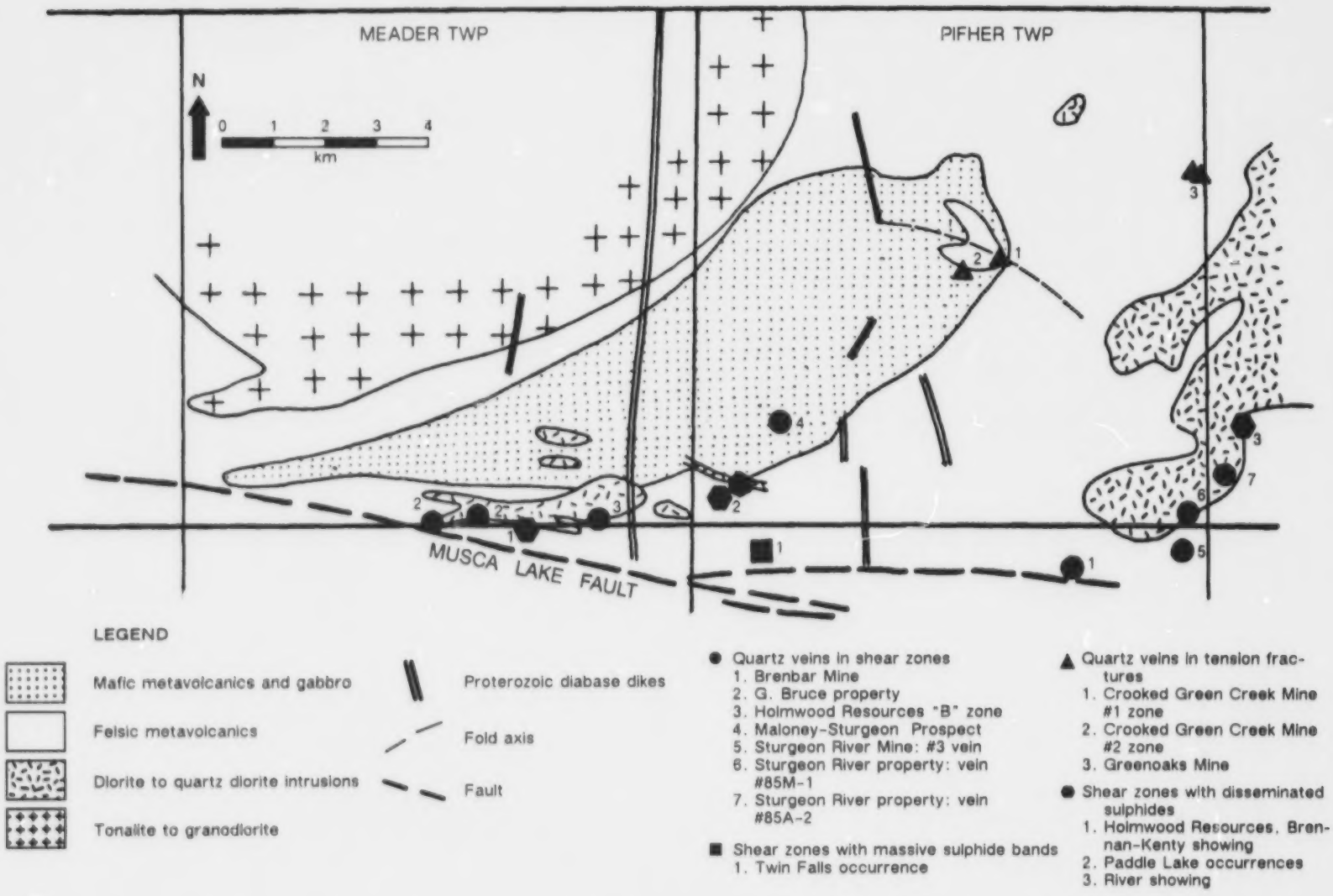

Figure 15. *Sketch map showing the location of selected gold occurrences, prospects and mines according to their deposit-type classification.*

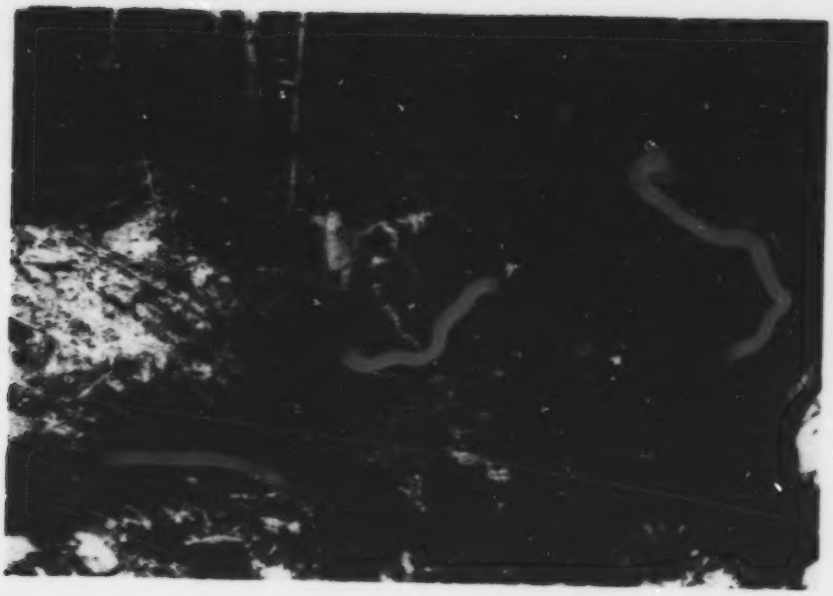

Photo 22. *Gold-bearing quartz vein occupying a shear zone in metamorphosed quartz diorite. Vicinity of the Sturgeon River Gold Mine, southeast Pifher Township.*

Photo 23. *The No.3 vein on Sturgeon River Mine property exposed in a trench at the Pifher-Irwin Township boundary. Boudins form a two-dimensional pinch and swell structure, conferring a "chocolate-tablet" configuration to the vein. The vein occurs in a shear zone within metamorphosed quartz diorite, at the southern margin of the Elmhirst Lake stock. It possesses a typical ribboned structure imparted by a "crack and seal" emplacement mechanism. Gold mineralization is restricted to the vein. Pifher Township.*

closer spaced and much thicker near the vein wall, suggesting that the vein developed by incremental fracturing, i.e., a crack-and-seal mechanism (cf. Ramsay 1980).

A sampling program by Phoenix Gold Mines Limited (Halladay 1985) showed that economic gold concentrations are typically confined to the vein. Visible gold may be seen along the chlorite-sericite part-

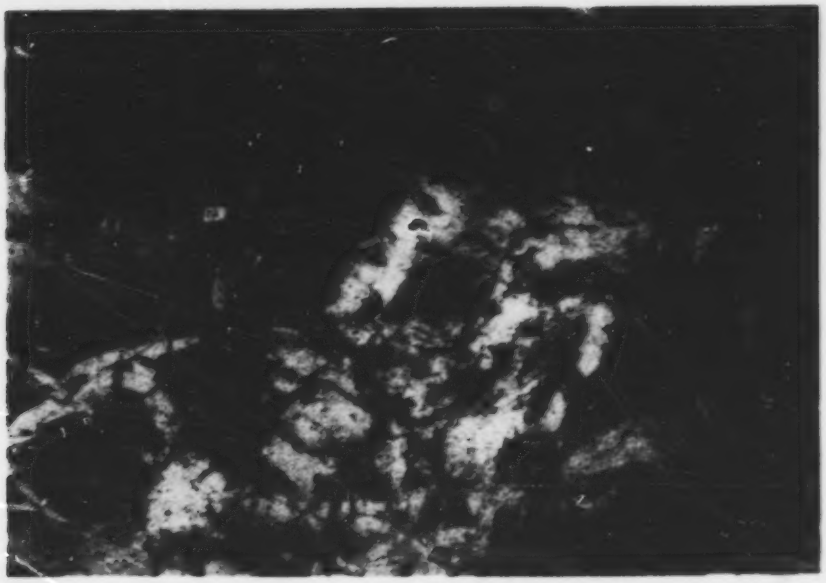

Photo 24. *Steeply dipping quartz vein occupying a tension fracture in felsic metavolcanic rocks. A Proterozoic diabase dike has been intruded along the vein. On the lower left, a large number of veinlets branch away from the main vein; these have probably been emplaced by hydraulic fracturing of the host rock. Note the lack of fabric in the metavolcanic rock. Northeastern Irwin Township.*

ings, suggesting gold has been preferentially deposited in these narrow bands. The vein quartz is usually white and well-fractured.

On the Sturgeon River property, auriferous quartz veins have been reported to contain narrow, glassy quartz veinlets that fill secondary fractures, whereas barren quartz veins are devoid of this secondary quartz (V. Shein, Phoenix Gold Mines, personal communication, 1986). At the Maloney Sturgeon prospect, gold was found in a lens-shaped pod within a shear zone exposed over 300 metres; it is probably part of a highly boudinaged vein. On the G. Bruce property in Meader Township, a quartz vein appeared to be very discontinuous.

The style of mineralization is highly variable from one deposit to another. Production figures from the No. 3 vein at the Sturgeon River Mine (*see* Table 14) suggest that gold grades were consistent throughout the mined portion of the vein. In contrast, gold mineralization at the Maloney Sturgeon prospect has proven to be highly erratic.

The gold occurs in the free state in quartz, or within pyrite. Silver is usually associated with the gold. Sulphide mineralization is variable in both quantity and mode of occurrence. Pyrite is the most common sulphide; however, chalcopyrite can also be plentiful, such as at the G. Bruce showings in Meader Township. Sulphides occurring in lesser amounts are pyrrhotite, sphalerite, and galena.

GOLD IN QUARTZ VEINS FILLING TENSION FRACTURES

Gold mineralization in quartz veins within tension fractures occurs at the Crooked Green Creek Mine and the Greenoaks Mine. Both deposits have similar settings and styles of mineralization.

Unlike the shear zone hosted veins which may be followed for several hundreds of metres, veins in tension fractures have shorter strike lengths. At both mines the auriferous deposits are single veins occupying fractures along lithologic contacts. At the Crooked Green Creek No. 1 zone, and at the Greenoaks Mine, the veins occur at a contact between felsic volcanic rocks and intrusive feldspar porphyry. At the Crooked Green Creek No. 2 zone, the corresponding contact is between gabbro and intermediate to felsic volcanic rocks. In these examples, the host rock lacks the strong schistosity which characterizes shear zone deposits, except for small-scale shears in the wall rock.

Quartz-filled tension fractures are common throughout the map area. West of Crooked Green Creek quartz veins abound, filling numerous parallel fractures (*see* Photo 14). Commonly, these veins are barren. Near the Sturgeon River Mine, the host rock to the wide, tension-fracture-filling quartz vein shown on Photo 24, displays subsidiary veins. These are believed to be filling hydraulic fractures.

The veins at both the Crooked Green Creek and the Greenoaks mines are richly mineralized with gold and sulphides. According to Mason and White

(1986), the average grade of vein material mined ranged between 0.2 and 0.5 oz gold per ton.

From field relations, it appears that the Crooked Green Creek Mine deposit is emplaced at or near a fold axis. Tight folding perhaps generated open fractures along the contacts of folded layers. The fracture system at the Greenoaks Mine may have been produced by a similar mechanism but the lack of top indicators does not permit the identification of folds.

GOLD MINERALIZATION IN DUCTILE SHEAR ZONES

Auriferous sulphide mineralization is found in a number of shear zones in felsic to intermediate volcanic rocks. These deposits have been subdivided into two types, based on the mode of occurrence of the sulphides: 1) disseminated sulphides in ductile shear zones; and 2) massive sulphide veins or lenses. Despite descriptive differences, the two types are probably closely related.

Mineralized ductile shear zones are represented by the Holmwood showings near the Meader–Sandra township line, the Peddle Lake occurrences, the Twin Falls occurrence, and several shear zones delineated by diamond drilling in southwestern Elmhirst Township. Mineralized shears have, in many cases, been outlined by magnetic and electromagnetic surveys, as on the Holmwood Resources property or in southwestern Elmhirst Township. The Brennan–Kenty showing, near the west end of Musca Lake in Meader Township, consists of a 300 m long shear zone mineralized with pyrite, chalcopyrite, gold and silver (Mackasey 1975). At Peddle Lake (Peddle Lake Mining Corporation option, Pifher Township; Sweany Gold Corporation option, Pifher Township) a number of shear zones, up to 2 metres wide, contain various amounts of pyrite and chalcopyrite. In two places, the sulphides form a narrow seam in the centre of the shear. A number of northeast-trending shear zones occur in southeastern Pifher Township and southwestern Elmhirst Township. They are outlined by electromagnetic conductors (Speed 1982). Reported mineralization (Assessment Files Research Office, Ontario Geological Survey) consists of pyrite with various amounts of chalcopyrite and sphalerite. Gold has been encountered in several drill holes (*see* Carling Gold Resources *in* Description of Properties).

At the Twin Falls occurrence in northern Irwin Township, a shear zone, several tens of metres wide in felsic metavolcanics, hosts a discrete sulphide band. This band consists of pyrite set in a siliceous boxwork several centimetres wide (Photo 25). The band is in sharp contact with a highly sericitic schist. Gold is present in much higher concentrations within the massive pyrite band than in the surrounding sericite schist (Mason and White 1986). Sulphide rich zones are characterized by thick gossan (Photo 26) at the Twin Falls occurrence, and mineralized shears at Peddle Lake. The common alteration products are silica, carbonate, sericite, albite, chlorite and sulphide minerals. The shear zones have been intensively altered and may have been highly permeable fluid conduits.

Photo 25. *Shear zone in felsic metavolcanic rocks, showing a massive pyrite band; Twin Falls occurrence. Northeastern Irwin Township.*

RELATIONSHIPS OF GOLD DEPOSITS TO GEOLOGICAL FEATURES

In the Beardmore–Geraldton area, two supracrustal domains may be distinguished, based on lithologic character and structure (Mason and White 1986). The Beardmore–Geraldton belt (Mackasey 1970b) is essentially a north-facing sequence of mafic volcanic rocks and sediments, structurally characterized by east-trending faults. The belt is bounded to the north by the Paint Lake Fault. North of the Paint Lake Fault, the Tashota–Onaman terrain (Mason and White 1986) consists mainly of volcanic rocks and granitic plutons, and is dominated by folds, in contrast to the homoclinal panel style of the Beardmore–Geraldton belt. These distinct domains host gold deposits representing different metallogenic environments.

In the Beardmore–Geraldton belt, much gold mineralization is related to late fractures in banded

Photo 26. *Gossan overlying a sulphide zone in sheared felsic metavolcanics; lying on strike with the Twin Falls occurrence shown in Photo 25. Northern Irwin Township.*

iron formation within epiclastic metasediments (Macdonald 1982, 1983; Anglin and Franklin 1985). The deposits have a close spatial association with regional scale shear zones.

Within the map area considered part of the Tashota–Onaman greenstone belt, gold mineralization is associated with: 1) early granitic intrusions, 2) large scale faults, 3) topographic lineaments, 4) fold axes, and 5) zones of pervasive metasomatism. Figure 16 shows the location of the various gold deposits with respect to these features.

Early Granitic Intrusions

A definite spatial relationship exists between gold and metamorphosed granitic rocks of intermediate composition. For example, at the Sturgeon River property, gold-bearing quartz veins in shear zones occur at the southern margin of the Elmhirst Lake stock (diorite and quartz diorite) in Pifher Township. Similarly, in southern Meader Township the G. Bruce property and the Holmwood Resources property occur along the southern contact of an elongated quartz diorite stock.

Another example is the Greenspar occurrence, situated 1 km to the northwest of Miner Lake in Pifher Township, where mineralized fractures carry anomalous gold concentrations. The host rock is a plagioclase-amphibole porphyry whose central portion is composed of hornblende-bearing quartz diorite and diorite.

The cause of the spatial relation between gold and the early intrusions is not clear. Perhaps the ductility contrast between the intrusive rocks and fragmental volcanic rocks may have been responsible for focussing strain during tectonism. The resulting shear zones and fractures ultimately became mineralized through hydrothermal processes. This model may be supported by the presence of the Musca Lake Fault just south of the map area.

Faults

The location of certain gold deposits along major east-trending faults (*see* Figure 16) indicates that structures such as the Musca Lake Fault, and the Paint Lake Fault to the south of the present map area, provided a regional control for gold mineralization. An example of a deposit directly related to faulting is the Brookbank prospect in central Irwin Township, which is on a portion of the Paint Lake Fault. Deep drilling by Metalore Resources Limited, in 1986, resulted in a significant discovery. Another example is the Brenbar Mine in northeastern Irwin Township which lies directly on the Musca Lake Fault. Furthermore, the showings in southern Meader Township, and the Sturgeon River Mine, probably bear some relationship to the Musca Lake Fault, given their proximity to it.

The Paint Lake and Musca Lake faults represent ductile shear zones which, according to their associated alteration (Kowalski 1987), undoubtedly acted as channelways for mineralizing hydrothermal fluids.

Topographic Lineaments

A large number of topographic lineaments within the map area are probably the surface expression of

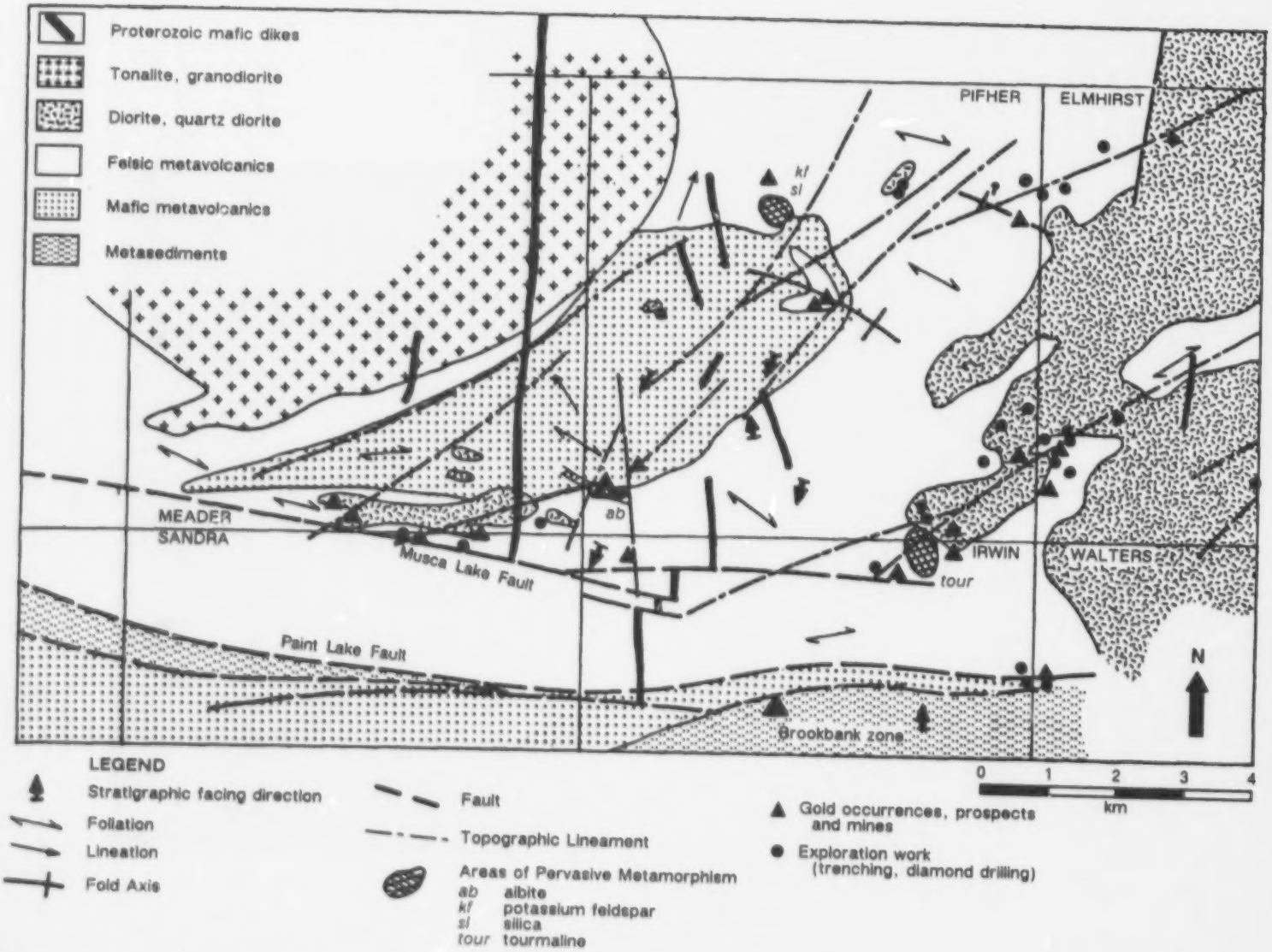

Figure 16. *Geological sketch map showing the location of gold deposits with respect to lithology (contact zones), structure (faults, fold axes, topographic lineaments), and zones of pervasive metasomatism. The Paint Lake Fault marks the boundary between the Beardmore-Geraldton belt and the Tashota-Onaman belt in the area covered by this figure.*

structures that have been enhanced by glacial erosion. Such structures may be lithologic contacts, shear zones, alteration zones, or a combination of these. A majority of lineaments trend northeast (*see* Figure 16), parallel to the flow direction of Pleistocene glaciers. Photo 17 shows a narrow northeast-trending shear zone strongly eroded by ice action. Such erosional channels have been filled by till that conceals bedrock features. Several gold showings occur along lineaments, such as shown on Photo 27. As can be seen on Figure 16, many trenching and drilling sites are located along lineaments.

Folds

Structural considerations in central Pifher Township, based on north-facing stratigraphy and the shape of distinct mappable units, suggest tight folding about southeast-trending axes in the Crooked Green Creek Mine area. The mine lies at the apex of a crescent-shaped inlier of an intermediate flow, structurally underlying basalt and gabbro. The fractures hosting the gold at the Crooked Green Creek Mine have likely been generated during the folding of a rock sequence consisting of a variety of lithologies.

The Greenoaks Mine resembles the Crooked Green Creek Mine in many ways. However, the lack of evidence for facing directions makes it difficult to decipher folding events and what effect they might have had on rock fracturing.

Pervasive Metasomatism

Several areas of pervasive metasomatism have been encountered in the field. In almost every case, gold mineralization occurs in proximity to these alteration zones at distances ranging between tens to a few hundred metres. The principal alteration zones are shown on Figure 16 and are described below.

TOURMALINE ALTERATION ON THE STURGEON RIVER PROPERTY.

Tourmaline, a product of boron metasomatism, is found as a replacement mineral in volcanic rocks in northeastern Irwin Township and southeastern Pifher Township. In Pifher Township, tourmaline has been observed within narrow, white quartz veinlets and as a replacement mineral at the edge of volcanic fragments within felsic pyroclastics. Tourmaline is also associated with secondary epidote. South of the map area in Irwin Township, spectacular examples of tourmaline replacement occur (*see* Photo 21). An exposure several tens of metres wide consists of a mafic tuff breccia in which the clasts have been entirely replaced with black tourmaline and the interclast material has been intensely silicified and sericitized. This provides a spectacular colour contrast between the clasts and the tuffaceous matrix.

At some distance away from that intense alteration zone, the replacement is weaker; the mafic clasts most altered are those near quartz-filled fractures which acted as channelways for the fluids. The unal-

Photo 27. *High angle, oblique aerial view over Paddle Lake showing areas of overburden stripping done in 1985 and 1986 to expose numerous shear zones and quartz veins. A pronounced north-striking lineament is clearly visible near the top of the photograph. The Twin Falls gold occurrence (TF, upper right), on which exploration was conducted by Noranda Exploration Limited, and the Maloney-Sturgeon Mine (MS) are situated along the lineament; PL marks the Paddle Lake occurrences. Meader and Pifher townships.*

tered clasts contain abundant dark green chlorite indicating that either iron or magnesium was significant in the formation of tourmaline.

ALBITE-PUMPELLYITE ALTERATION NEAR PEDDLE LAKE.

On the south side of Peddle Lake, andesitic rocks recently exposed by overburden stripping and trenching display a peculiar pink and green weathered surface. The colouration is caused by secondary albite and pumpellyite. (Mineral identification was done using X-ray diffraction techniques, by W.D. Hicks, Geoscience Laboratories, Ontario Geological Survey. The albite and pumpellyite occur as fine-grained replacements, and within veins. Associated common minerals are actinolite, chlorite, calcite, and quartz. The pink colour is attributed to hematite. Brown titanite and specular hematite also have been found in narrow fractures. The extent of the alteration halo has not been established due to the overburden cover in the area; however, it has been traced for several tens of metres in the trenches. Gold mineralization has been found in the felsic rocks several tens of metres away from the altered basalt.

SILICA AND POTASSIC ALTERATION.

Just south of the eastern arm of Pifher Lake, felsic metavolcanic rocks with a high content of plagioclase phenocrysts have a strong pink colouration on the weathered surface. In one exposure, the rock is cut by a large number of narrow, anastomosing quartz veins. Staining for potassium revealed a high potassium feldspar content present in discrete hairline cracks, along the silica-filled veins and in patches throughout the rock (*see* Photo 20). The extent of this pink coloured alteration halo is approximately 300 m. A grab sample from a white quartz vein on the northern shore of Pifher Lake returned an assay of 2260 ppb Au (Geoscience Laboratories, Ontario Geological Survey). A sample taken from a felsic tuff breccia exposure, just south of the contact with the mafic rocks and 2500 m northeast of Peddle Lake, shows signs of silicification and the presence of small specks of green muscovite (fuchsite?) scattered throughout felsic clasts.

GENERAL RELATIONSHIPS BETWEEN THE VARIOUS GOLD DEPOSITS

A large number of gold showings occur in the southern part of the map area, which may suggest that gold mineralization is associated with the east-trending faults of the Beardmore–Geraldton belt. These gold deposits are all hosted within east-trending shear zones associated with ductile deformation at, or near, the boundary between the Beardmore–Geraldton belt and the Tashota–Onaman belt.

Several structures mineralized with gold, such as the G. Bruce property occurrences and the showings at Musca and Pirum lakes, form a linear array in southern Meader Township. This observation may be useful for further exploration, reflecting the possibility that mineralization may occur elsewhere, within the present confines of the array, or beyond its presently recognized limits.

Gold deposits in quartz veins which fill tension fractures, such as at the Crooked Green Creek and the Greenoaks mines, are located well within the Tashota–Onaman terrane, suggesting that these deposit types are spatially and genetically unrelated to deposits within major shear zones. Based on these criteria, it is possible to distinguish two categories of gold deposits within the map area.

BASE METAL SULPHIDE DEPOSITS

Within the present map area, base metal sulphide deposits are of two types: 1) disseminated mineralization within shear zones in felsic to intermediate metavolcanic rocks, and 2) sulphides within quartz veins. In northwestern Elmhirst Township, a mafic intrusion contains copper-nickel mineralization. No molybdenum mineralization has been found to date. Copper is by far the most common base metal present within the map area.

Copper–Nickel

A mafic stock known as the Pinel Creek intrusion, in northwestern Elmhirst Township, has been extensively investigated for its copper and nickel potential. Mackasey and Wallace (1978) give a detailed account on the deposit. A mineralized zone consisting of 937 538 tons of 0.42 percent copper and 0.41 percent nickel has been delineated by diamond drilling. It is believed that the deposit has a magmatic origin. Mineralization typical of the Pinel Creek intrusion has not been found within the present map area. Mackasey and Wallace (1978) describe the intrusion as being layered, in contrast with the homogeneous gabbroic rocks found within the present area.

Copper–Zinc

In Archean greenstone belts, economic copper-zinc ± lead-silver deposits are commonly of the strata-bound, volcanogenic massive sulphide type (Sangster and Scott 1976; Franklin et al. 1981). Within the map area, all known sulphide mineralization is confined to fracture systems in felsic to intermediate, volcanic and intrusive rocks; no apparent relationship to stratigraphy has been found. This mineralization is therefore probably of epigenetic origin; gold is usually associated with this type of sulphide mineralization.

Disseminated Sulphides in Shear Zones

Ductile shear zones, within felsic to intermediate volcanic rocks and their related intrusions, commonly are mineralized with variable amounts of disseminated pyrite and chalcopyrite. Zinc ± copper mineralization has been reported from diamond drilling along the Namewaminikan River in southwestern

Elmhirst Township (Mackasey and Wallace 1978). Zinc mineralization has been found only in minor quantities, associated with other sulphides, in Pifher and Meader townships. It occurs in small podiform masses at Peddle Lake, and on the G. Bruce west showing in Meader Township, where it has been found together with galena.

Pyrite and chalcopyrite form lenticular masses in the middle of shear zones. On surface, these masses are not more than several centimetres thick. These concentrations probably reflect increased hydrothermal activity in the shears which acted as channels for mineralizing fluids. Sulphides in shear zones are found at Peddle Lake, on the Holmwood Resources property in southern Meader Township, along the Namewaminikan River in Elmhirst and Pifher townships, and on the Greenspar property north of Miner Lake. The sulphide mineralization in shear zones normally define electromagnetic conductors (Speed 1982).

Sulphides in Quartz Veins

All auriferous quartz veins mentioned above are mineralized to some extent with sulphides, regardless of whether the veins occupy shear zones or tension fractures. Some quartz veins, such as those on the Sturgeon River property, contain relatively little sulphide mineralization, with most of this being fine-grained disseminated pyrite along, or within, the country rock. Such veins as those at the Crooked Green Creek deposit, or the Greenoaks Mine, carry significant amounts of sulphides as disseminations, stringers or small irregular masses of chalcopyrite, pyrrhotite and pyrite. Sulphide concentrations locally form up to 30 percent of the vein and were emplaced during late fracturing and brecciation. At the Crooked Green Creek Mine and the Greenoaks Mine, where sulphides are relatively abundant, the gold content is also high, an observation that suggests that the sulphides and the gold are coeval.

PLATINUM GROUP METALS

Platinum group metals (PGM) mineralization has not been found within the map area. The field party collected various phases of the Proterozoic mafic rocks for platinum and palladium analysis. The results of these analyses are shown on Table 12. The table lists slightly anomalous concentrations of palladium, platinum and gold in the coarsest phases of the diabase near Mungo Park Point in Barbara Township. These coarse (pegmatitic) phases occur as tabular, flat-lying patches up to 1 or 2 metres in length. The mineralogy is similar to the enclosing finer textured diabase. Individual crystals of pyroxene and plagioclase are up to 5 cm long. The pegmatitic phases probably represent late crystallizing parts of the sill that have been enriched with volatile phases. According to R.H. Sutcliffe (Ontario Geological Survey, personal communication, 1986), these pegmatitic patches are confined to the upper part of the extensive Nipigon sills.

Mackasey (1975) reports a trace of palladium in medium-grained diabase, mineralized with finely disseminated pyrite and chalcopyrite, from Dorothea Township.

The Pinel Creek intrusion, a mafic stock of Archean age located in northwestern Elmhirst Township, is known to host a nickel-copper deposit. At the time of writing, no documented investigation had been carried out with regard to possible PGM mineralization associated with the sulphides.

ORNAMENTAL AND BUILDING STONE

Attempts were made by Greenspar Mines Limited, in 1965, to evaluate the use of porphyritic diabase (locally known as "greenspar porphyry") from a 30 m wide dike south of Forge Lake in Pifher Township. On a polished surface (*see* Photo 15), a pleasing appearance is given by the presence of large, euhedral to subhedral, saussuritized plagioclase phenocrysts which have a soft yellowish-green colour. This material may be used as building stone, facing material,

TABLE 12. ANALYSES OF THREE PROTEROZOIC MAFIC INTRUSIVE ROCKS (DIABASE) AND ONE ARCHEAN GABBRO, FOR PRECIOUS METAL CONTENT.

Sample No.	Twp.	Rock Type	Ni (ppm)	Pt (ppb)	Pd (ppb)	Au (ppb)	Ag (ppm)
86-0174	Pifher	Archean gabbro 5% pyrrhotite	30	1	<1	<2	<2
86-0279	Pifher	Diabase, aphanitic chill margin	54	<1	<1	nd	nd
86-0308A	Barbara	diabase, pegmatitic	nd	8	35	12	<2
86-0308B	Barbara	diabase, medium grained	nd	6	16	4	<2

nd—not detected

analyses done by the Geoscience Laboratories, Ontario Geological Survey.

and for decorative items. The porphyritic dike is known to be exposed for a distance of 50 km south of Forge Lake, passing through the town of Beardmore.

SAND AND GRAVEL

Deposits of sand and gravel are abundant throughout the southern part of Pifher and Meader townships, and in the eastern and northern parts of Pifher Township along Highway 801. These deposits have been used extensively for the construction of access roads in the area. A widespread area underlain by sand occurs in southeastern Pifher Township, north of the Namewaminikan River.

Description of Properties

Property descriptions are listed alphabetically under the names of the owners as of September 22, 1986. The location of these properties is shown on Maps 2536 and 2537 (backpocket). Parcels of land which were unstaked on September 22, 1986, but for which assessment data is available, are listed on the maps by the last company which held the ground and the year in which the last assessment data was submitted; this date is in square brakets.

The field party visited all of the properties described, and was able to locate and sample many of the workings and showings in the map area. All samples collected during the present work were analyzed at the Geoscience Laboratories, Ontario Geological Survey.

Details of the history of the properties are taken from company records filed with the Assessment Files Research Office in Toronto, the Beardmore–Geraldton Resident Geologist's office in Thunder Bay, Ontario Geological Survey reports, and from individuals and companies active in the area.

Table 11 lists the sources of information on properties in Pifher and Meader townships, respectively, and the type of work performed. As of December 31, 1986, no assessment data were available for Barbara Township.

There was a total of 812 registered claims in the map area on September 22, 1986, of which 409 were in Pifher Township, including 63 surveyed claims; 213, in Meader Township; and 190, in Barbara Township.

T. AUGER

In 1986, T. Auger held a block of 10 unsurveyed claims (TB 862009, TB 862010, TB 873886 through TB 873893), south of Miner Lake in the northeast quadrant of Pifher Township.

In 1960, Chellew Mines Limited drilled one hole, totalling 162 metres, on the east side of Crooked Green Creek, 500 m south of the bridge on Highway 801 at Miner Lake. Nothing of interest was found.

An airborne magnetic and electromagnetic survey was conducted in the summer of 1986, by Terraquest Limited for Sweany Gold Corporation, who had an option on the property.

The property is underlain by feldspar porphyry and intermediate tuffaceous metavolcanic rocks.

AUGMITTO EXPLORATIONS LIMITED

Augmitto Explorations Limited held a group of eight surveyed, leased claims (TB 317341, TB 317343 through TB 317345, TB 318086 through TB 318087, TB 318089 through TB 318090) in the eastern part of Pifher Township, in 1986.

The earliest work, in 1971, was a program of prospecting and electromagnetic surveying (Assessment Files Research Office, Ontario Geological Survey). In 1972, an induced polarization survey detected two zones of anomalous chargeability, one of which corresponds to an airphoto lineament which crosses the property in a northeast direction. Additional work in 1972 and 1973, including a second induced polarization survey, a ground magnetometer survey and overburden stripping, delineated several zones of chalcopyrite and pyrite mineralization in feldspar porphyry on the property. The geophysical anomalies and surface showings were drilled during 1972 and 1973. Five holes, totalling 1000 m, were drilled to test for gold, silver and copper mineralization. One hole, on claim TB 317344, intersected an 11.5 m section averaging 0.02 ounce gold per ton, 0.20 ounce silver per ton and 0.76 percent copper (Assessment Files Research Office, Ontario Geological Survey). A ground magnetometer and electromagnetic study was completed in 1983 over the property.

GEOLOGY AND MINERALIZATION

The property is underlain by diorite, quartz diorite and tonalite of the Elmhirst Lake stock, and massive feldspar porphyry. The feldspar porphyry is cut by northwest-trending quartz porphyry dikes.

Mineralization is exposed in three showings. One showing occurs on the east side of Highway 801 on claim TB 317344 and consists of a 30 cm wide by 3 m long, north-trending quartz vein. The vein contains small pods of pyrite and chalcopyrite with surficial malachite staining. A grab sample obtained from this showing assayed 10 ppb gold and 8 ppm silver.

The second showing on claim TB 317343 is a shear zone, 2 m wide and 100 m long, trending 050° and mineralized with chalcopyrite, pyrrhotite, and pyrite. Central portions of the shear zone are occupied by 1 to 2 cm wide quartz veinlets with patches of pyrite. Two samples were collected by the field crew and assayed. One sample returned 0.19 ounce silver per ton; a second sample assayed 16 ppb gold.

The third showing, exposed in three trenches on the south side of a pond on claim TB 318089, is an east-trending shear zone, 200 m long and 1 to 2 m wide. Mineralization consists of pyrite and disseminated pyrrhotite in feldspar porphyry, and chalcopyrite in narrow, fractured, 2 to 3 cm wide quartz veins. A grab sample from this showing returned 0.18 ounce silver per ton. Several, narrow, northeast-trending shear zones are exposed approximately 100 m south of the pond on claim TB 318089. In places, these

shears are silicified and carry up to five percent fine-grained pyrite.

A. BAARTS, P. SKALESKY, J. TERNOWESKY

Peddle Lake Mining Corporation Option

In 1986, Peddle Lake Mining Corporation, a subsidiary company of Atlantic Mining Corporation of Minneapolis, Minnesota, was formed to carry out exploration work on a group of 92 unsurveyed claims in southern Pifher and Meader townships, and in Sandra Township. These claims include what are referred to locally as the "Peddle Lake occurrences". The claim group is formed by several blocks that were held, in 1986, by three owners.

Baarts: TB 863242 through 863249 and TB 863262 through 863270, Pifher Township; TB 863250 and TB 845250 through 845253, Meader Township; TB 863252 through 863259 Sandra Township

Skalesky: TB 864338 through 864356, Pifher Township; TB 864318 through 864330, Meader Township

Ternowesky: TB 863663 through 863668, Pifher Township; TB 863724 through 863729 and TB 863736 through 863752, Meader Township

During the summer of 1986, a control grid covering the entire property was cut. Magnetometer and VLF-EM survey were conducted and geological mapping and prospecting were carried out on this grid.

The exploration program was centred on claim TB 863244, just south of Peddle Lake. The emphasis was on an induced polarization anomaly which had been delineated by Lynx–Canada Explorations Limited in 1974, in a survey of a group of six claims. An extensive program of overburden stripping and trenching, undertaken to expose shear zones and quartz veins (*see* Photo 27), was followed by systematic channel sampling of shear zone and quartz vein material. Toward the end of the summer of 1986, a diamond-drilling program was initiated.

Laird (1936, p.117) mentions exploration work that had been done in the Peddle Lake area, on what was then known as the Taylor–Segsworth claim.

> "A considerable amount of stripping and trenching has been done near the centre of the unsurveyed Taylor–Segsworth claim T.B. 12,937, about 1 mile north of Twin Falls, in Pifher Township. The showings consist of rusty quartz veins and mineralized shear zones in a broad dike of granite porphyry, which trends in a general easterly direction. Gold is reported to have been found in some of the pits, but on the whole the mineralization is not impressive."

According to Map 45a accompanying Laird's report, the location of the diggings are about 700 m to the east of the occurrence worked by Peddle Lake Mining Corporation.

In 1959, John Petrick drilled 11 diamond-drill holes with an aggregate length of 1400 feet (427 m). Another three holes, totalling 460 feet (140 m), were drilled during the years 1969–1970. No gold mineralization was encountered (Assessment Files Research Office, Ontario Geological Survey).

GEOLOGY

The 92-claim group is underlain by the southern margin of a basalt-gabbro assemblage which has been intruded by numerous northwest-trending quartz porphyry dikes along which shear zones have been developed. The southern limit of the claim group straddles the contact between the felsic volcanic rocks and the mafic assemblage. Several north-trending Proterozoic diabase dikes intrude the Archean volcanic rocks, and at Peddle Lake a diabase outlier occurs on each side of the lake.

The stripped and trenched area south of Peddle Lake was mapped in detail (Figure 21, backpocket) and 37 grab samples of shear-zone and quartz-vein material were collected for gold and silver analysis (Table 13). The area covered by claim TB 863244 and adjoining claim TB 863167 to the south, on which exploration was conducted in 1985–1986 by Sweany Gold Corporation, are situated at a major east-trending contact between mafic volcanic rocks and their related gabbro intrusions to the north, and fragmental felsic volcanic rocks to the south. The metavolcanics are intruded by a northwest-trending tonalitic dike several tens of metres wide, emplaced at the contact between mafic and felsic volcanic rocks; and by several feldspar porphyry dikes trending in the same direction.

Numerous northwest-trending shear zones intersect volcanic and intrusive rocks and commonly occur at lithologic contacts. The shear zones are a few centimetres to 3 m wide and dip steeply to vertically. The sense of shearing, based on several determinations, is in all cases dextral. A number of highly irregular quartz veins occur within the shears.

Mineralization within the shear zones and the quartz veins consists of disseminated pyrite, chalcopyrite and pyrrhotite. Malachite stains are abundant on the south shore of Peddle Lake (*see* Figure 21, location PL7 (back pocket)), where chalcopyrite is present. Clear, tabular gypsum crystals were found to fill small cracks within a 0.2 m wide shear zone at this location. The sulphate for the gypsum results from the oxidation of pyrite. A 10 cm wide lens, rich in pyrite, sphalerite, and minor chalcopyrite (*see* Figure 21, location PL14, backpocket), was found within a highly silicified shear zone in gabbro at the southern end of Peddle Lake. Two samples, assayed by the Geoscience Laboratories, Ontario Geological Survey, returned 0.01 ounce gold per ton for a sample mineralized with sphalerite and 0.04 ounce gold per ton for a sample mineralized with pyrite (samples PL14A and PL14B, respectively).

Of the 37 grab samples analyzed (*see* Table 13), seven returned anomalous gold values, i.e., above 100 ppb, but only one (PL15) returned an economic

TABLE 13. GOLD CONTENTS OF GRAB SAMPLES TAKEN AT THE PEDDLE LAKE OCCURRENCES.

Sample Number	Au (ppb)	Ag (ppm)	Sample Description
PL06	26	<2	- Quartz vein material, 1% pyrite
PL07	<0.01*	<0.1*	- Shear zone material in andesite; quartz stringers—2-5% pyrite
PL10	2	<2	- White quartz vein material in chlorite schist
PL12	6	<2	- Silicified shear zone in quartz-feldspar porphyry; minor pyrite
PL13	<0.01*	<0.1*	- Shear zone in feldspar porphyry; disseminated pyrite
PL14A	0.01*	<0.1*	- Silicified shear in mafic dike with sphalerite pod, pyrite and chalcopyrite
PL14B	0.04*	<0.1*	- Idem.; pyrite rich zone
PL15	0.15*	<0.1*	- Silicified shear zone in feldspar porphyry; pyrite rich lenses
PL16	280	<2	- Silicified shear zone in feldspar porphyry; very finely disseminated pyrite
PL19	<0.01*	0.34*	- White quartz vein mineralized with chalcopyrite lenses
PL22	26	5	- Shear at contact between feldspar porphyry dike and dacitic volcanic rocks; minor pyrite
PL23	2	<2	- Narrow shear zone in feldspar porphyry; quartz vein, small pyrite pods
PL24	34	<2	- Narrow shear zone in feldspar porphyry; quartz masses and some pyrite
PL25	11	<2	- Quartz vein material; pyrite blebs
PL27	35	<2	- Quartz vein material with pyritic wall rock
PL28	0.03*	<0.10*	- Quartz vein material from shear zone in feldspar porphyry, small masses of pyrite
PL32	2	<2	- Shear zone with abundant quartz; minor pyrite and pyrrhotite
PL33	60	<2	- Material from a quartz pod at contact between tonalite and chloritic schist
PL34	<0.01*	<0.1*	- Chlorite schist with abundant quartz, disseminated pyrite
PL36	5	<2	- Quartz vein material from shear zone
PL38	320	2	- Narrow shear zone with quartz veinlets carrying disseminated chalcopyrite
PL42	34	<2	- Sericite schist in tonalite
PL43	<2	<2	- Quartz vein in tonalite, limonite stains
PL44	<0.01*	<0.1*	- Shear zone at tonalite—feldspar-porphyry contact, minor pyrite
PL46	160	<2	- Shear zone in feldspar porphyry, quartz veinlets, minor pyrite
PL48	190	<2	- Shear zone in slightly carbonatized tonalite
PL50	27	<2	- Boudinaged quartz vein in shear zone at contact between dacitic volcanic and feldspar porphyry dike; blebs of pyrrhotite, pyrite and chalcopyrite
PL52	1010	11	- Sericite schist forming the contact between felsic tuff and tonalite, weathers to a rusty colour
PL53	0.02*	0.25*	- Sericite schist with a 1 cm thick seam of pyrite
PL54	0.01*	3.82*	- Silicified shear zone in tonalite, 10% chalcopyrite and pyrite
PL55	0.01*	<0.10*	- Quartz pod in chloritic shear zone, pyrite and minor pyrrhotite blebs
PL57	14	<2	- Chlorite schist, narrow quartz vein, minor pyrite
PL60	0.22*	<0.1*	- Shear zone with quartz vein in dacitic tuff, pyrite and chalcopyrite
PL61	0.14*	0.58*	- Quartz vein material with masses of chalcopyrite and pyrite from shear zone in dacitic volcanic rock
0227	0.06*	<0.1*	- Silicified shear zone with a 2 cm massive pyrite band
0228	<2	<2	- 0.7 m wide shear in feldspar porphyry with minor disseminated pyrite
0229	1030	2	- 0.7 m wide shear in feldspar porphyry with minor pyrite mineralization

**ounces per ton*

Analyses by the Geoscience Laboratories, Ontario Geological Survey.

grade—0.15 ounce gold per ton. Silver values were consistently low and most were below the detection limit of 2 ppm. Only samples PL19 and PL22 had anomalous silver contents, 0.34 ounce per ton and 5 ppm, respectively.

Andesitic rocks at Peddle Lake show obvious signs of metasomatic alteration. These rocks exposed by overburden stripping of an area some 250 m by 100 m, reveal peculiar colouration represented by green and pink minerals. These minerals are present as rock constituents as well as joint and fracture fillings. Petrographic and X-ray diffraction analyses have determined the peculiar green mineral to be pumpellyite and the pink mineral to be albite. The pink colouration is given by finely divided hematite. Other abundant secondary minerals are actinolite, chlorite and calcite. Light brown, euhedral titanite crystals 2 to 3 mm in size have been observed in a small fracture filled with calcite and pumpellyite. Specular hematite has also been noted in joints.

The tonalitic dike that has intruded at the contact between the mafic and felsic volcanic rocks has been slightly carbonatized in places, with a carbonate that weathers brown. Where carbonatized, the tonalite also carries disseminated grains of pyrite and pyrrhotite. Sheared rocks have been invariably altered with silica, chlorite, sericite, carbonate, and sulphides.

P. BERNIER

Sweany Gold Corporation Option

See G. Bruce—Sweany Gold Corporation Option

BRENBAR MINES LIMITED

Brenbar Mines Limited held three leased claims, TB 13561, TB 13564 and TB 13567, on the Pifher–Irwin township boundary along the Namewaminikan River in 1986, and an additional nine claims in Irwin Township.

The property has been previously described by Mackasey (1975).

G. BRUCE

Sweany Gold Corporation Option

In 1986, G. Bruce held 11 claims in two groups, herein referred to as the west and east groups, in the southern part of Meader Township. Claims TB 861638 through TB 861643 and TB 829016, located about 1 km west-northwest of Musca Lake, and claims TB 861636 and TB 861637 about 400 m northwest of Pirum Lake, constitute the west group. Claims TB 861644 and TB 861645, located some 500 m west of Peddle Lake, are the east group. These claims, along with 18 claims held by F. Houghton (TB 813480 through TB 813487 and TB 873454 through TB 873458) and 5 claims held by P. Bernier (TB 907565 through TB 907568 and TB 907570) in the southern part of Meader Township, were under option to Sweany Gold Corporation in 1986.

During the summer of 1986, airborne magnetic and electromagnetic surveys were conducted over the Bruce, Houghton and Bernier claims. Sweany Gold Corporation was also engaged in overburden stripping and trenching on two showings, here referred to as the east and west showings, both of which are on the G. Bruce west claim group.

The east showing, on claim TB 861641, consists of a 0.5 m wide northwest-trending shear zone in quartz diorite; it is exposed in a 70 m long trench. Quartz veins occupying the shear are mineralized with patches and disseminations of chalcopyrite and pyrite. A grab sample, collected during the present work, assayed 7400 ppb gold.

The west showing on claim TB 861641 is located 500 m southwest of the east showing. The occurrence is an east-trending shear zone in quartz diorite. Mineralization is in two forms: abundant disseminated pyrite with lesser sphalerite and chalcopyrite, in strongly silicified sericite schist; and patches of chalcopyrite and pyrite, with subordinate sphalerite and galena, in irregular quartz veins. Descriptions and assay values for samples collected during the present project are listed below:

1. Silicified schist with 15 percent disseminated pyrite—0.02 ounce gold per ton
2. Silicified schist with 25 percent sulphides as pyrite, sphalerite and chalcopyrite—0.14 ounce gold per ton, 0.26 ounce silver per ton
3. Vein quartz with chalcopyrite and pyrite—0.02 ounce gold per ton, 0.26 ounce silver per ton
4. Vein quartz with chalcopyrite and pyrite—0.06 ounce gold per ton, 0.58 ounce silver per ton
5. Vein quartz with chalcopyrite pyrite, sphalerite and galena 0.39 ounce gold per ton, 0.26 ounce silver per ton
6. Quartz-carbonate vein with chalcopyrite and pyrite—0.38 ounce gold per ton, 0.38 ounce silver per ton

An occurrence consisting of a series of sheared, near-vertical quartz veins, mineralized with pyrite and pyrrhotite, outcrops, over a width of 20 m and a length of 10 m, on the north side of a beaver pond within the east group of the G. Bruce claims. No gold or silver was detected in a grab sample collected at this site.

CARLING GOLD RESOURCES INCORPORATED

In 1986, Carling Gold Resources Incorporated held a group of 21 claims in Pifher and Elmhirst townships, of which 17 claims (TB 645422 through TB 645425, TB 645427 through TB 645430, TB 645433 through TB 645436, TB 645439 through TB 645442 and TB 645445) were in Pifher Township. The property is a portion of a larger claim group that was held by Carling Copper Mines Limited in the 1970s, extending into the southwestern part of Elmhirst Township and encompassing the original discovery site on the claim group.

In 1959, W.C. Martin discovered copper mineralization in Elmhirst Township at Barnum Green Rapids on the Namewaminikan River, about 1.3 kilometres east of the Pifher Township boundary. The mineralized occurrence, known as the "River showing", contains streaks and masses of chalcopyrite with subordinate pyrite in sheared, chloritic dacite flows (Pudifin 1971). Most of the exploration activity between 1959 and 1972 was centred on the "River showing" in Elmhirst Township and has been described by Mackasey and Wallace (1978).

In 1984, Carling Gold Resources Incorporated initiated a program of diamond drilling to investigate a series of electromagnetic anomalies, mainly in Pifher Township (Assessment Files Research Office). Between July 1984 and November 1985, Carling Gold Resources Incorporated drilled 13 holes in Pifher and Elmhirst townships, for a total of 1300 m (4267 feet). Hole CP-8, located about 400 m northeast of the Highway 801 bridge over the Namewaminikan River, intersected a 1.86 m (6.1-foot) section assaying 0.37 ounce gold per ton. Hole CP-1, situated 30 m southwest of hole CP-8, intersected a 0.82 m (2.7-foot) section assaying 0.13 ounce gold per ton (*The Northern Miner*, December 2, 1985). Mineralization consists of pyrite and pyrrhotite in a shear zone in dacite.

CHEMALLOY MINERALS LIMITED [1971]

In 1971, Chemalloy Minerals Limited held 4 unsurveyed claims (TB 296981 through TB 296984) in the northeast corner of Pifher Township, adjoining a group of 117 claims held by Chemalloy Minerals Limited in Elmhirst Township.

The property was centred on a granodiorite-hosted molybdenite showing in Elmhirst Township, which was discovered in 1971 by A. Mitto (Mackasey and Wallace 1978). Exploration activity and mineralization has been described previously by Mackasey and Wallace (1978).

M.F. COWAN

Maloney–Sturgeon Prospect

The Maloney–Sturgeon prospect is the site of the first gold discovery in the general Sturgeon River area and "was credited with precipitating the gold rush into the Sturgeon River area in the summer of 1934" (Laird 1936).

In 1986, the property on which the discovery zone lies consisted of a single claim (TB 862416) held by M.F. Cowan. Three adjoining claims to the west and south (TB 814988, 874409 and 874440) were held by N. Cox, C. Huston, P. Lassila, and D. Thorsteinson.

HISTORY

René Maloney discovered gold in a quartz vein east of Peddle Lake (Figure 17) in 1934. Twenty-two claims were staked for the Karl Springer Exploration Company. That same year, Maloney Sturgeon Gold Mines Limited was incorporated; a test pit was blasted on the discovery vein and several trenches were dug nearby, along a rusty shear which extends from the main vein. The following year, high grade gold mineralization was exposed when the main pit was enlarged. Forty tons of vein material were removed and a 364-pound shipment of hand-cobbed material yielded a gold brick weighing 21.4 ounces (Laird 1936). In 1937, one ton of ore was extracted; it yielded 72.6 ounces of gold and 16 ounces of silver. No further developments of any significance took place.

In 1975, a ground magnetometer survey was carried out on a 10-claim group staked by D. Pudifin in 1973.

In 1983, a group of four unsurveyed claims was optioned by R.J. McGowan from G. Harder, and a detailed geological mapping program was done on the claims. After the claims lapsed, McGowan restaked the ground of the original discovery as claim TB 862416. At the time of writing, the claim was registered under M.F. Cowan who conducted rock sampling in 1986. The highest gold value obtained from assaying was 0.157 ounce per ton.

GEOLOGY AND MINERALIZATION

The Maloney–Sturgeon prospect area is underlain mainly by pillowed basalt and gabbro. A detailed property map produced by K. Baker for R.J. McGowan (Assessment Files Research Office, Ontario Geological Survey) shows numerous outcrops with scattered irregular "banded ryholite" apparently hosted by basalt and gabbro. From the general structure of that part of Pifher Township, and similar observations made elsewhere, it appears that the felsic "banded rhyolite" is an intermediate to felsic flow that structurally underlies the basalt-gabbro assemblage at a very shallow angle. Thus, the showing may be related to shearing along a major lithologic contact. The volcanic rocks are intruded by numerous northwest-trending feldspar porphyry dikes. A prominent airphoto lineament passes through the discovery zone.

The discovery was made on a lens-shaped quartz vein striking 310° and dipping 70°S; it has a maximum width of 7 feet (2.1 m) (Laird 1936). From discarded vein material on the main dump, the quartz is white with a glassy luster and is well fractured. It possesses a ribboned structure imparted by thin chloritic bands and is mineralized with pyrite and lesser chalcopyrite. Galena has been reported by Laird (1936). The main vein is relatively short. However, it is emplaced on a strong, rusty shear zone dipping 45°W that has been followed for nearly 1000 feet (300 m) (Laird 1936). The shear is exposed in a large number of trenches to the south of the main pit. Gold mineralization was observed only in a 20-foot (6 m) long, extremely rich pocket within the main vein (Laird 1936). Sampling of quartz at the main zone, and at nearby veins, during subsequent exploration ventures failed to disclose significant gold values.

L. COX

In 1986, L. Cox held a group of 18 contiguous claims (TB 861873 through TB 861880 and TB 874462 through TB874471) in north-central Pifher Township. The property was originally investigated by Portrose Explorations Limited in 1966. The company drilled one hole on present claim TB 861875 for a length of 123 m.

In 1972, Labrador Exploration (Ontario) Ltd. conducted electromagnetic, magnetic, geological and rock geochemical surveys over the northern portion of this claim group.

The present research located an old trench on the west side of a small pond on claim TB 861880. This trench exposes a small shear zone which hosts pyrite and quartz stringers in a felsic volcanic rock. No gold was detected upon assay of a grab sample taken from this trench.

The bedrock exposures on this property consist of recrystallized tuff, lapilli tuff, tuff breccia and feldspar porphyry.

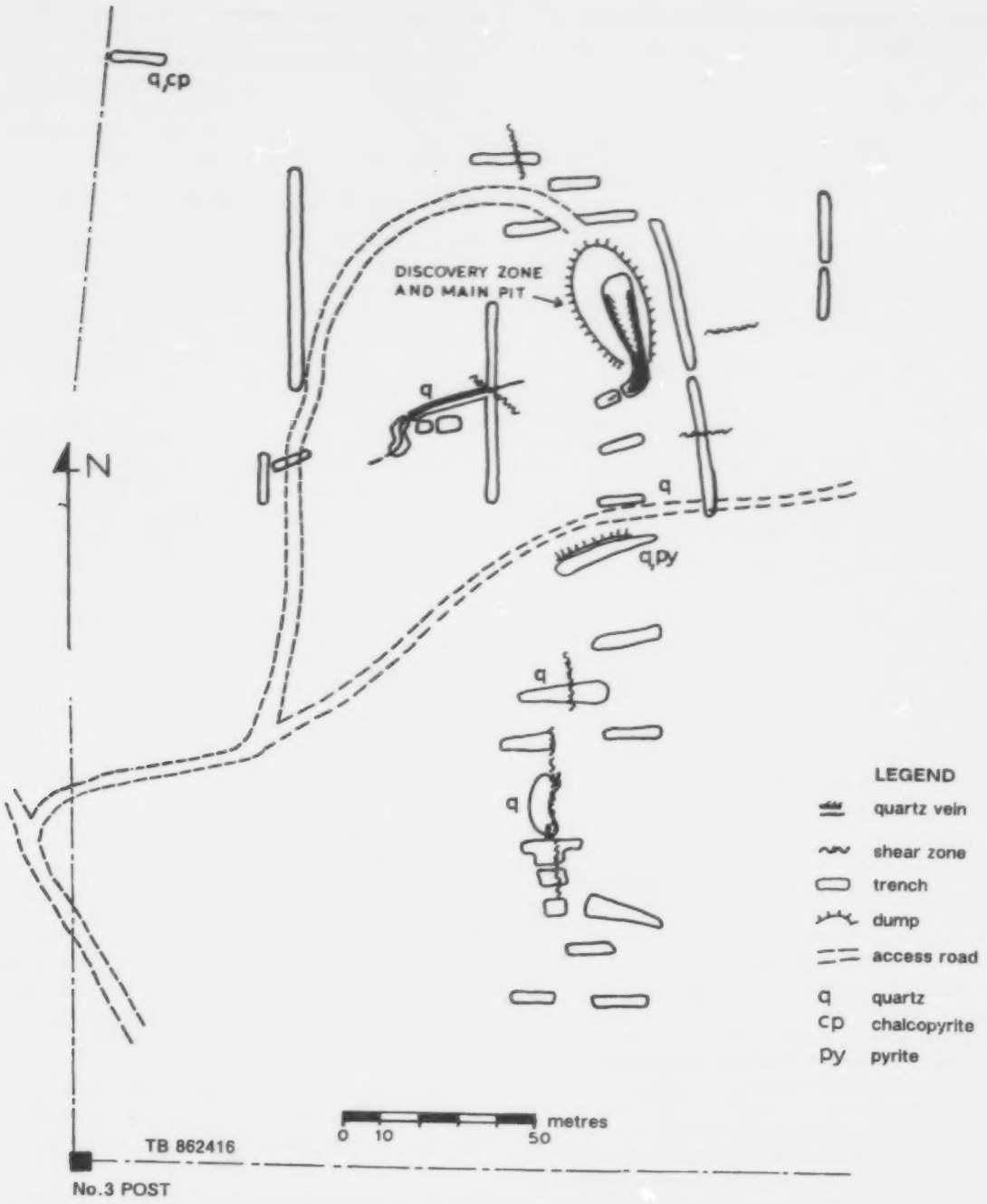

Figure 17. *Sketch showing the location of trenches on the Maloney–Sturgeon prospect; after a property plan by M.F. Cowan, Assessment Files Research Office, Ontario Geological Survey.*

N. COX, C. HUSTON, P. LASSILA AND D. THORSTEINSON

See property description under M.F. Cowan (Maloney–Sturgeon Prospect)

N. COX, P. LASSILA, D. THORSTEINSON

Sweany Gold Corporation Option (Peddle Lake Occurrence)

In 1986, Sweany Gold Corporation took an option to carry out exploration work on claim TB 863167 south of Peddle Lake, the site of previous exploration work. This claim covers a showing known as the Peddle Lake occurrence.

The first claim was staked on the site in 1944. Between that date and 1960, the occurrence was restaked several times. The first significant exploration on record was carried out in 1960 by J. Petrick, who did some trenching and diamond drilling on former claim TB 97772. Two holes with an aggregate length of 241 feet (73.5 m) were drilled. Some sulphide mineralization was encountered in sheared rock but no gold mineralization was detected (Assessment Files Research Office, Ontario Geological Survey).

In 1972, Petrick restaked the claim, as claim TB 351418, and subsequently performed further mechanical stripping, and diamond drilling of one 154-foot (50 m) hole. In 1976, Lynx Canada Explorations Limited conducted an induced polarization survey on a 6-claim group encompassing part of the Petrick property. Two, parallel, northwest-trending anomalies were outlined on the property and the ground to the east.

In 1985, claim TB 863167 was staked and transferred to N. Cox, P. Lassila and D. Thorsteinson, who did power stripping and sampling (Mason and White 1986). In 1986, Sweany Gold Corporation carried out further stripping to expose shear zones and started a diamond-drilling program.

On the property, gold mineralization occurs in sulphide-bearing shear zones in felsic volcanic rocks. The shears, up to 1 m in width, trend northwest and occur along contacts between feldspar porphyry dikes and fragmental felsic volcanic rocks (*see* Figure 21, back pocket). The shears have been strongly silicified, such as at sample locations PL 54 and 0227, shown on Figure 21. Some shears host narrow, white, boudinaged quartz veins. Sulphide mineralization consisting of disseminated chalcopyrite, pyrite and pyrrhotite, occurs in the shears. At sample location 0227, a 2 cm wide massive pyrite seam is present at the centre of a 0.7 m wide shear. Some sulphide-bearing shears are deeply weathered on surface and have developed secondary limonite, malachite, azurite and gypsum.

A total of 10 grab samples were collected during the present work; assay results from these samples are listed in Table 13. The highest gold content was 0.22 ounce per ton from a shear situated 40 m to the west of the road. A large number of analytical values are listed in Mason and White (1986), in which the highest quoted gold content is 11.58 ounce per ton. Silver is highly anomalous in some shears: the highest value obtained from the project's sampling is 3.82 ounces silver per ton and highest reported value by Mason and White is 5.34 ounces silver per ton.

DOME EXPLORATION (CANADA) LIMITED

In 1979, airborne electromagnetic and magnetic surveys were flown over the general Sturgeon River area, encompassing the southern half of Pifher and Meader townships, by Questor Surveys Limited for Dome Exploration (Canada) Limited. No follow-up work was done by Dome in either township (Assessment Files Research Office, Ontario Geological Survey).

C. ENDERS

C. Enders held nine contiguous claims (TB 815176 through TB 815184) in eastern Pifher Township.

An induced polarization survey was carried out by Augmitto Explorations Limited over the southern portion of the claim group in 1973. No other assessment work on the property is on record.

Underlying lithologies are predominantly diorite and quartz diorite of the Elmhirst Lake stock, and feldspar porphyry.

J.J. GRAY

In 1986, J.J. Gray held 26 leased claims (TB 65314 through TB 65318, TB 65321 through TB 65322, TB 65330, TB 65333 through TB 65334, TB 65337 through TB 65338, TB 65343 through TB 65346, TB 85652 through TB 85655, TB 93412, and TB 93658 through TB 93661) east of Tyrol Lake in Pifher Township. These claims encompass the previously worked Coleman–Gray property.

The earliest recorded work on the property was by the Dumond Mining and Exploration Company Limited, which held 15 claims east of Tyrol Lake in 1935. Laird (1936) notes some diamond drilling on the property although no important results were obtained.

Between 1946 and 1948, Dajaty Mines Limited intermittently carried out prospecting and geological mapping on the property, following the discovery of gold-bearing quartz veins.

In 1955, the property was staked by a syndicate consisting of J.J. Gray, F. Coleman, and E. Carlson. Between 1956 and 1961, a program of trenching, stripping, electromagnetic and magnetic surveys, and the diamond drilling of five holes totalling 490 m, was completed by J.J. Gray. The property was brought to lease in 1964.

The Coleman–Gray property is underlain by gabbro and basaltic units represented by massive to pillowed flows. Locally, the basalts have acquired a strong planar fabric. They are mapped as chlorite

schist. Other rock types are massive diorite from a small plug centred on claims TB 65333 and TB 65338, feldspar porphyry dikes, intermediate to felsic volcanic rocks, and quartz monzonite of the North Wind Lake pluton in the western portion of the claim group.

The main showing occurs on claim TB 65333 (Assessment Files Research Office, Ontario Geological Survey). The present investigations located a east-trending, steeply dipping quartz vein, at least 20 m long and 2 m wide. The vein, which cuts gabbro, is mineralized with pyrite, pyrrhotite, and chalcopyrite. No anomalous gold values were detected from a grab sample of quartz vein material taken as part of this project. Schistose mafic volcanics have been reported to be mineralized with pyrite, pyrrhotite, arsenopyrite, chalcopyrite, and gold in places (Beardmore–Geraldton Resident Geologist's files).

GREENSPAR MINES LIMITED [1965]

In 1965, Greenspar Mines Limited made an attempt to evaluate a Proterozoic porphyritic diabase dike, locally known as "greenspar porphyry", in central Pifher Township as a source of building and ornamental material. Tyson (1965b) states that "When cut and polished the diabase has a distinctive, pleasing, unique appearance" (*see* Photo 15). The property, located just south of Forge Lake, consisted of mining claim TB 113677 and Rock File (Quarry Permit) 155607. On the property, the dike strikes 020° and is up to 40 m wide.

Characteristic phenocrysts of yellowish green plagioclase measure up to 5 cm in diameter and serve to distinguish this dike from other diabase dikes in the area; these are typically devoid of phenocrysts. The phenocryst content was reported by Tyson (1965b) to range between 15 and 25 percent and to have a tendency to be concentrated along the walls of the dike. The host rock of the dike is pillow basalt.

Over 2 tons of the diabase was quarried in 1965 and a marketability study was done.

An estimated 1 000 000 tons of porphyritic rock occurs on the property, over a strike length of 1000 feet (305 m), a width of 100 feet (30 m) and an assumed depth of 120 feet (36 m) (Tyson 1965b).

This particular porphyritic diabase dike is known to strike approximately north for at least 3.5 km from Forge Lake and more than 50 km south, passing through the town of Beardmore.

HILLSBOROUGH EXPLORATION LIMITED

Crooked Green Creek Mine

See property description under Northern Concentrators Limited.

HOLMWOOD RESOURCES LIMITED

Parquet Resources Incorporated Option

Holmwood Resources Limited held two claim groups in the southern part of Meader Township and adjacent Sandra Township in 1986. The property has previously been described by Mackasey (1975, p.71-75).

HISTORY

The Holmwood Resources Limited property consists of several mineralized zones which have been intermittently explored since the mid 1930s. According to Mackasey (1975), mineralization around Pirum and Musca lakes occurs in four zones indicated as the A, B, C and D zones. Zones B and D are in Meader Township while zones A and C occur west of Pirum Lake and at Musca Lake, respectively, in Sandra Township.

The D zone, located north of Musca Lake on claims TB 350208 and TB 350209, was originally explored by the Brennan and Kenty Bros. Prospecting Company Limited in 1935. Early work on the property has been described by Laird (1936, p. 91-92).

The B zone is located 180 m north of Pirum Lake and is centred on present claims TB 613520 through TB 613522. The following work is on record for the B and D zones combined: a self-potential survey by J. Zmudzinski in 1963; geological, electromagnetic and self-potential surveys by S. Witwer in 1965-66; 10 diamond-drill holes totalling 454 m in 1966; overburden stripping by H.M. Holm in 1971 (Mineral Deposits files, Assessment Files Research Office, Ontario Geological Survey).

During 1984 and 1985, Holmwood Resources Limited drilled seven holes, totalling 273 m, on claim TB 613522 on the B zone, and claim TB 632238 at the east end of the property.

In 1984, Holmwood Resources Limited completed magnetic and electromagnetic surveys over the eastern part of their claim group.

A portion of the eastern segment of the Holmwood Resources Limited claim group was examined by the Spooner Sturgeon River Syndicate in 1935. Laird (1936, p.116–117) describes a showing, presumed to be located about 1.5 km northeast of Pirum Lake, consisting of a broad shear zone carrying a system of quartz stringers mineralized with pyrite and chalcopyrite.

In 1954, Bobjo Mines drilled two holes, totalling 110 m, on claim TB 632283 approximately 600 m west of Peddle Lake (Assessment Files Research Office, Ontario Geological Survey) in search of a copper showing. Nothing of interest was located.

GEOLOGY AND MINERALIZATION

The property is underlain by porphyritic tuff and lapilli tuff, intruded by a small, metamorphosed quartz diorite stock cut by feldspar porphyry dikes.

Mineralization in the D zone consists of chalcopyrite and pyrite in an east-trending, 1 m wide shear zone traced for 300 m by Mackasey (1975). A grab sample collected by Mackasey (1975) from old Brennan and Kenty workings contained 2.53 percent copper, 0.26 ounce gold per ton and 0.64 ounce silver per ton. A grab sample collected by the present field party from a more recent trench just east of the Brennan and Kenty trenches, assayed 0.08 ounce gold per ton and 0.58 ounce silver per ton.

From the field observations, the B zone showing consists of a 30 cm wide shear zone striking 115° for at least 50 m. Mineralization consists of quartz, chalcopyrite, pyrite and massive magnetite. Malachite and azurite are abundant on the weathered surface. Three samples, representing three different types of mineralization, were collected by the field party and assayed. Sample descriptions and results are given below:

1. White quartz with pyrite mineralization—8,200 ppb Au, 4 ppm Ag
2. Massive magnetite with minor chalcopyrite—560 ppb Au
3. Quartz with chalcopyrite mineralization—80 ppb Au

F. HOUGHTON

Sweany Gold Corporation Option

See G. Bruce (Sweany Gold Corporation option)

LABRADOR EXPLORATION (ONTARIO) LIMITED [1972]

Labrador Exploration (Ontario) Ltd. staked a group of 40 contiguous claims in north-central Pifher Township in 1971. The southern portion of their claim block is now part of the L. Cox and A. Rosenblatt claim groups in Pifher Township. Work performed in 1972 included electromagnetic, magnetic, geological, and rock geochemical surveys. Nothing of economic interest was found and the claims were subsequently canceled in 1973.

The property is underlain by felsic to intermediate, recrystallized tuffs, monolithic tuff breccia, and subordinate feldspar porphyry and gabbro dikes.

E. MARUSKA

Minefinders Occurrence

In 1986, E. Maruska held a main block of 17 contiguous unsurveyed claims (TB 861808 through TB 861824) and 6 claims (TB 861807, TB 861794, TB 801795, TB 861790 through TB 861792) in three small groups in the southeast quadrant of Pifher Township.

In 1935, Kirkland–Hudson Bay Gold Mines Limited held a group of six claims on the west side of Crooked Green Creek. Laird (1936, p.115) describes a north-striking shear zone in feldspar porphyry carrying stringers of bluish quartz mineralized with pyrite, chalcopyrite and galena.

Most activity in the past, on the main block of Maruska claims, has centred on the Minefinders occurrence located at the west end of the claims at the boundary of the P. Skalesky (Peddle Lake Mining Corporation option) claims. Laird (1936, p.115) writes:

> "Minefinders Limited holds a group of 9 unsurveyed claims (T.B. 13,733 to 13,741) just west of the third rapids upstream on Crooked Green Creek. A trail leads north from the rapids to the workings, less than half a mile distant. A quartz vein, 3 feet wide, is exposed on the east side of a hill and in the bed of a stream; it strikes N.10°W. and dips 45°W. The quartz contains a little pyrite and ankerite, and is reported to have yielded spectacular gold specimens."

In 1959, R. Newman and J. Pollock diamond drilled three holes, totalling 110 m, on the Minefinders occurrence. Quartz veins, occasionally mineralized with pyrite and chalcopyrite, were encountered in the drill core (Assessment Files Research Office, Ontario Geological Survey).

M.F. Cowan conducted a geological and a ground magnetic survey over the Minefinders occurrence in 1983 and 1984.

Part of the eastern portion of the main block of the Maruska claims was examined with an induced polarization survey by Augmitto Explorations Limited in 1972.

The Maruska property is underlain by intermediate flows, lapilli tuffs and tuff breccia, all cut by feldspar porhyry and quartz porphyry.

Numerous parallel quartz veins, 5 to 20 cm wide and trending 020° to 040°, were located in the vicinity of the Minefinders occurrence during the present work. The quartz is grey and carries various amounts of pyrite and chalcopyrite commonly stained with malachite.

Two samples, obtained during the current work, of sulphide deficient quartz veins assayed 29 ppb and 24 ppb gold, respectively. A third sample, obtained from a several metres long quartz vein with localized blebs of chalcopyrite, assayed 750 ppb gold. Low silver concentrations were noted in all three samples.

P. MEALEY

In 1986, P. Mealey held two blocks of claims in central Pifher Township. A block consisting of two claims (TB 925899, TB 925900) was geologically mapped in 1983 and magnetically surveyed in 1984, by M.F. Cowan. These claims are underlain by intermediate flows and fine-grained gabbro.

A second block of 15 claims (TB 925867 through TB 925874 and TB 925892 through TB 925898) adjoins to the east, the 26 leased claims of J.J. Gray. These 15 claims are underlain by pillowed mafic flows, fine-grained gabbro and feldspar porphyry. Several barren quartz veins outcrop within this block, on Forge Lake. No mineralization was noted during current work.

W. MIRON

In 1986, W. Miron held two claims (TB 908348 and TB 908349) centred on Miner Lake in Pifher Township.

The only work on record for the property is a ground electromagnetic survey encompassing Miner Lake, by Anyox Metals Limited in 1982.

The property is underlain by intermediate tuffs and lapilli tuffs. No mineralization was noted by the present field party.

A. MITTO

In 1986, A. Mitto held 34 claims (TB 767891 through TB 767894, TB 803515 through TB 803529, TB 803538 through TB 803540, and TB 940995 through TB 941006) in the southeastern quadrant of Pifher Township.

Laird (1936 p.114) describes overburden stripping and trenching by the Jackpine Sturgeon Gold Syndicate, Limited on narrow quartz veins east of Crooked Green Creek.

Augmitto Explorations Limited carried out a program of prospecting, an induced polarization survey and a ground magnetometer survey during 1971 and 1972, and ground magnetometer and electromagnetic surveys in 1983, over the northeastern portion of the property (Assessment Files Research Office, Ontario Geological Survey).

In October 1985, A. Mitto carried out overburden stripping and trenching on the mineralized occurrences on claim TB 803516 in the southeastern corner of the property.

In the summer of 1986, Terraquest Limited flew airborne magnetic and electromagnetic surveys over 30 claims for A. Mitto.

The property is underlain by intermediate tuffs, lapilli tuffs, tuff breccia, and flows. Feldspar porphyry and quartz diorite of the Elmhirst Lake stock are exposed in the southeast corner of the property. Extensive Pleistocene sand deposits cover a large portion of the southern and central part of the property.

Two mineralized showings on claim TB 803516, 2.2 km west of the southeast corner of Pifher Township, referred to here as the north and south showings, occur 500 m and 100 m north of the Namewaminikan River, respectively. Both showings are hosted by coarse-grained, massive quartz diorite.

The north showing is a vertical, 0.3 m wide quartz vein, striking 010°, mineralized with patches of pyrite and disseminated galena. Chlorite veinlets are present within a quartz vein and are parallel to it. A grab sample of vein material, obtained by the field party, assayed 12 ppb gold and 10 ppm silver.

The south showing consists of several, narrow, parallel quartz veins striking 010° and mineralized with chalcopyrite and pyrite.

J. NABIGON

In 1986, J. Nabigon held two blocks of claims in the map area. One block of three claims (TB 874219 through TB 874721) was located in central Pifher Township. A second block of 18 claims (TB 874201 through TB 874218) was located in south-central Meader Township southwest of Tyrol Lake.

The Pifher Township claims cover a portion of the Minefinders occurrence (*see* E. Maruska, above). M.F. Cowan carried out geological mapping, in 1983, and a ground magnetic survey, in 1984, on these claims.

The Pifher Township claims are underlain by intermediate flow rocks and fine-grained gabbro. Numerous barren quartz veins occur on these claims.

The Meader Township claims are underlain by monolithic tuff breccia, mafic flows, fine-grained gabbro, and feldspar porphyry. No mineralization was noted during the present work.

J. NABIGON AND A.R. NABIGON

J. Nabigon and A.R. Nabigon held a block of 48 contiguous claims (TB 874241 through TB 874288) in Pifher Township in 1986.

There is no record of work on the property, although the field party located trenches in a quartz vein approximately 1.5 km north-northeast of the Maloney–Sturgeon gold prospect on claim TB 874260. The quartz vein strikes north, is 1.5 m wide and has been traced for 230 m. The vein is unmineralized, except at the contact with sheared country rock where it carries pyrite. A grab sample of this material assayed 20 ppb gold.

The property is underlain by gabbro, and massive and pillowed mafic flows.

NORTHERN CONCENTRATORS LIMITED

Crooked Green Creek Mine

In 1986, Northern Concentrators Limited held a group of 29 contiguous unsurveyed mining claims (TB 518561 through TB 518562, TB 557581 to TB 557583, TB 614044 through TB 614045, TB 614737, TB 644990 through TB 644994, TB 646035 through TB 646044, TB 656582, TB 701436 through TB 701440) and one surveyed mining claim (TB 113679) in central Pifher Township. These claims enclose three unsurveyed mining claims (TB 602243 through TB 602245) and three surveyed mining claims (TB 34902, TB 34905 and TB 34908) held by Hillsborough Exploration Limited. Exploration work on the properties of Northern Concentrators Limited and Hillsborough Exploration Limited was carried out principally in four zones, Nos. 1, 2, 4 and 5, (Fig-

ure 18), two of which, the No. 1 and No. 2 zones, have been mined for gold.

HISTORY AND PRODUCTION

In 1946, Neil Smith staked a group of 15 claims after visible gold had been discovered on the site of the No. 1 zone, on present claim TB 113679 (Horwood 1946). The original group of claims included TB 34902, TB 34905 and TB 34909, which are presently under lease to Hillsborough Exploration Limited. The Neil Prospecting Syndicate conducted a program of trenching to test gold mineralization on the property.

The property was then optioned to Green Lake Gold Mines Limited in 1947, who drilled 17 short, diamond-drill holes to intersect the No. 1 vein over a length of about 55 m. The weighted average of the 17 quartz vein intersections was reported to be 1.32 ounces gold per ton across 0.45 m (Halladay 1966). Quartz vein intersections by Green Lake Gold Mines Limited, in eight, short, drill holes on the No. 2 zone, 500 m west of the No. 1 zone, averaged 0.38 ounce gold per ton over 1.4 m. Green Lake Gold Mines Limited sampled the No. 4 zone, 150 m south of the No. 1 zone, in 1947. Reported assays for gold include 4.11 ounces per ton over 6 cm, 0.4 ounce per ton over 12 cm, and 0.46 ounce per ton over 21 cm (company report, Green Lake Gold Mines, 1947, Beardmore–Geraldton Resident Geologist's files).

In 1958, the property was acquired by Chellew Gold Mines Limited who optioned it to the Martin–Sturgeon Syndicate. A program of trenching, stripping, sampling, and diamond drilling of 20 holes for a total of 1940 m, was conducted (Mason and White 1986). The diamond drilling was targeted on the main (No. 1) vein and the No. 4 zone.

In 1960, the property was returned to the vendors who subsequently optioned it to W. Brown. An unknown number of holes were drilled east of the main (No. 1) vein (Halladay 1966).

In 1964, T. Christianson restaked six claims, including the site of the No. 1 vein, after the claims of Chellew Gold Mines lapsed (Halladay 1966). Christianson sampled the No. 1 vein over a length of 72 m and reported an average assay of 5.9 ounces gold per ton over a width of 0.82 m. In 1965, Christianson shipped a 12.58 ton bulk sample of sorted vein material which assayed 4.9 ounces gold per ton, 0.75 ounce silver per ton, and 1.5 percent copper (Halladay 1966).

In 1966, Crooked Green Creek Mines Limited optioned six claims from T. Christianson and G.W. Moore, purchased leased claims TB 34902, 34905 and 34908 from Man-Echo Mines Limited, and

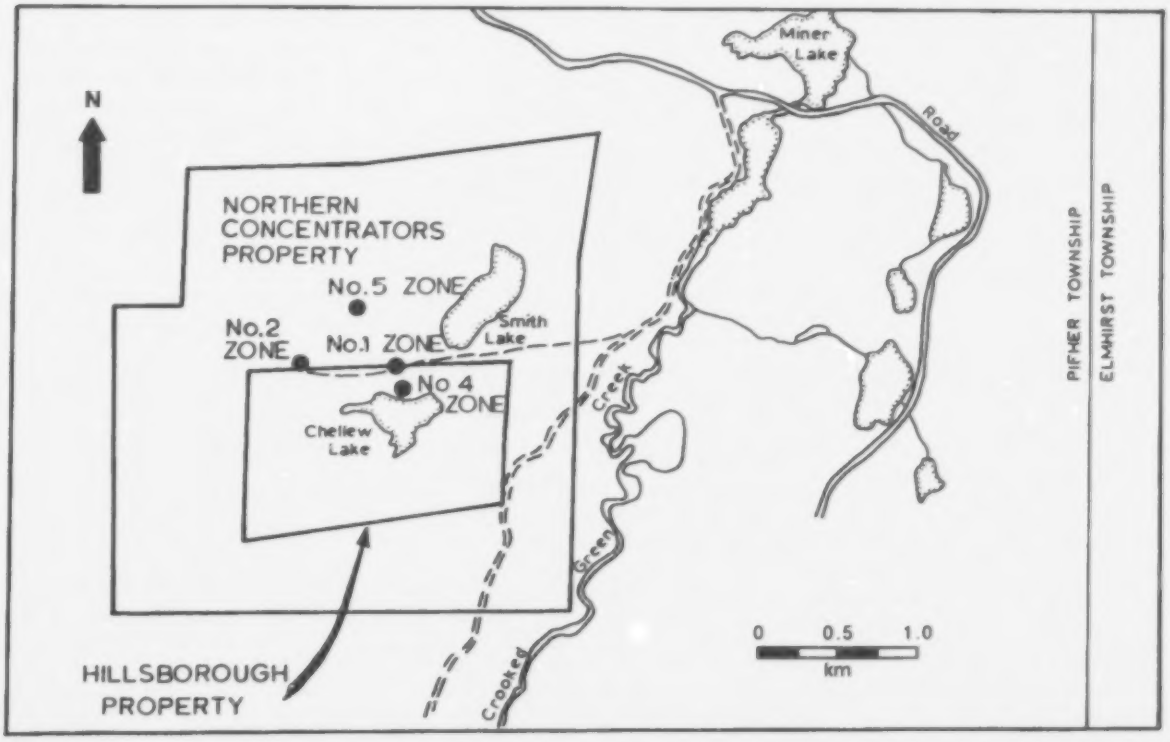

Figure 18. *The principal zones of exploration and development on the Northern Concentrators and Hillsborough properties, after Anglo Canadian Mining Corporation report, Beardmore–Geraldton Resident Geologist's files.*

staked an additional 25 claims adjoining the property (Halladay 1966). Mining claim TB 113679 was brought to lease in 1966.

The same year, Crooked Green Creek Mines Limited sank a 9.4 m (31-foot) deep shaft at an angle of 45° into the No. 1 vein (*see* Frontispiece). The following year, the shaft was extended to a depth of 11.6 m (38 feet). During the period 1966-1967, 70 tons of ore were mined. (Riddell 1967). In 1966, Crooked Green Creek Mines Limited conducted a program of surface sampling on the No. 1, No. 2, and No. 4 zones. Two chip samples from the No. 2 vein assayed 2.36 ounces gold per ton over a width of 0.76 m and 20.8 ounces gold per ton over a width of 0.91 m (Halladay 1966). In 1967, an additional 39, short, diamond-drill holes were completed, for a total of 620 m (Riddell 1967), and magnetic and induced polarization surveys were conducted on the property.

In 1972, Algoma Development Company (S. and B. Cowan), acquired the property, less claims TB 34902, TB 34905, TB 34908, TB 602243, TB 602244 and TB 602245, which are held by Hillsborough Exploration Limited (Mason and White 1986). Algoma Development Company initiated a 5-ton-per-day mining and milling operation on the No. 1 vein (*The Northern Miner*, July 27, 1972). At the time, the mine had the distinction of being the smallest producing mine in Ontario (Ontario Mineral Review 1973, p.45). In 1981, the company was renamed Northern Concentrators Limited and a 35-ton-per-day mill was built in Thunder Bay to handle ore from the mine (Mason and White 1986). The total production from the No. 1 vein for 1980–1982 is reported to have been 915 tons of ore at 0.265 ounce gold per ton (*George Cross News Letter*, No. 238, 1982, Beardmore–Geraldton Resident Geologist's files).

In 1983, Northern Concentrators Limited and Hillsborough Exploration Limited entered into an agreement to jointly option their claims on the property to Great Western Petroleum Corporation and Anglo-Canadian Mining Corporation, a consortium which became known as the Thunder Bay Joint Venture (Mason and White 1986). The consortium conducted a program of geological mapping, ground magnetometer and electromagnetic surveys and diamond drilling.

Twenty-six holes, for a total of 704 m, were drilled to further test the No. 1 zone (*see* Figure 22, backpocket). Drill hole 1-C-22, 59.4 m in length, was drilled on the No. 4 zone just north of Chellew Lake (local name). The best gold assay obtained, 0.047 ounce per ton over 0.52 m, was across narrow chalcopyrite and quartz veins. Eighteen holes, for a total of 488 m, were drilled to test the No. 2 zone (Figure 19, Figure 20).

Mining, on a small scale, of the No. 2 vein was initiated in 1984 under the Thunder Bay Joint Venture agreement. A total of 790 tons of ore, with a recoverable grade of 0.425 ounce gold per ton, were mined (Carter 1985). An additional 200 tons of ore were mined from the No. 2 zone in 1985 (Mason and White 1986). Six vertical drill holes, totalling 305 m, to test the extension of the No. 2 vein on claim TB 518562, were completed in 1985 (*see* Figure 19). In 1985, the Thunder Bay Joint Venture retained only the Hillsborough option (Mason and White 1986). During 1986, one 54.86 m drill hole was completed by Anglo-Canadian Mining Corporation on Hillsborough claim TB 602243, southeast of Chellew Lake (local name). Nothing of economic interest was reported. In 1986, Northern Concentrators sampled quartz veins at the No. 5 zone on claim TB 644992, approximately 500 m northwest of the No. 1 vein.

GEOLOGY

The Crooked Green Creek property occurs at the contact between the assemblage of mafic volcanic rocks and gabbro that underlies much of the western half of Pifher Township and intermediate to felsic volcanic rocks that surround the mafic rocks. Felsic dikes and small stocks, represented by feldspar porphyry, intrude the volcanic rocks.

Numerous erosional windows within the mafic assemblage expose inliers of the intermediate to felsic units, particularly near its southern margin. This suggests that the contact between the sequences dips north at a very shallow angle. The largest of these windows occurs just west of the shaft and consists of a massive andesite flow, similar to the flows in the terrain to the south. This suggests that the flow is in part structurally overlain by older mafic rocks, i.e., that the stratigraphy is overturned.

That window is over 1 km long and crescent-shaped; the nose of the cresent abuts the No. 1 zone. The crescentic shape strongly suggests the presence of a tight fold whose axial plane would pass through the No. 1 zone. Little further evidence supports the presence of a fold axis due to the lack of stratigraphic facing indicators. If indeed folding has been the cause for the crescentic shape of the inlier, then the fold is either a west-plunging syncline, or as previously suggested by Andrews (1973), an east-plunging anticline. The fold would be compatible with the much larger anticlinal or domal structure produced by the intrusion of the North Wind Lake pluton.

The western part of the property is underlain by massive to pillowed, melanocratic basalt and related gabbro, with a medium- to coarse-grained texture. The eastern part of the property is underlain mostly by part of an extensive andesite flow unit extending from Meader Township into central Pifher Township. This flow structurally underlies, at least in part, the gabbro-basalt assemblage. The flow unit is characterized by flow banding which is spectacularly developed at the No. 2 zone and resembles thin bedding in tuffs. Spherulitic horizons are also exhibited at several outcrops.

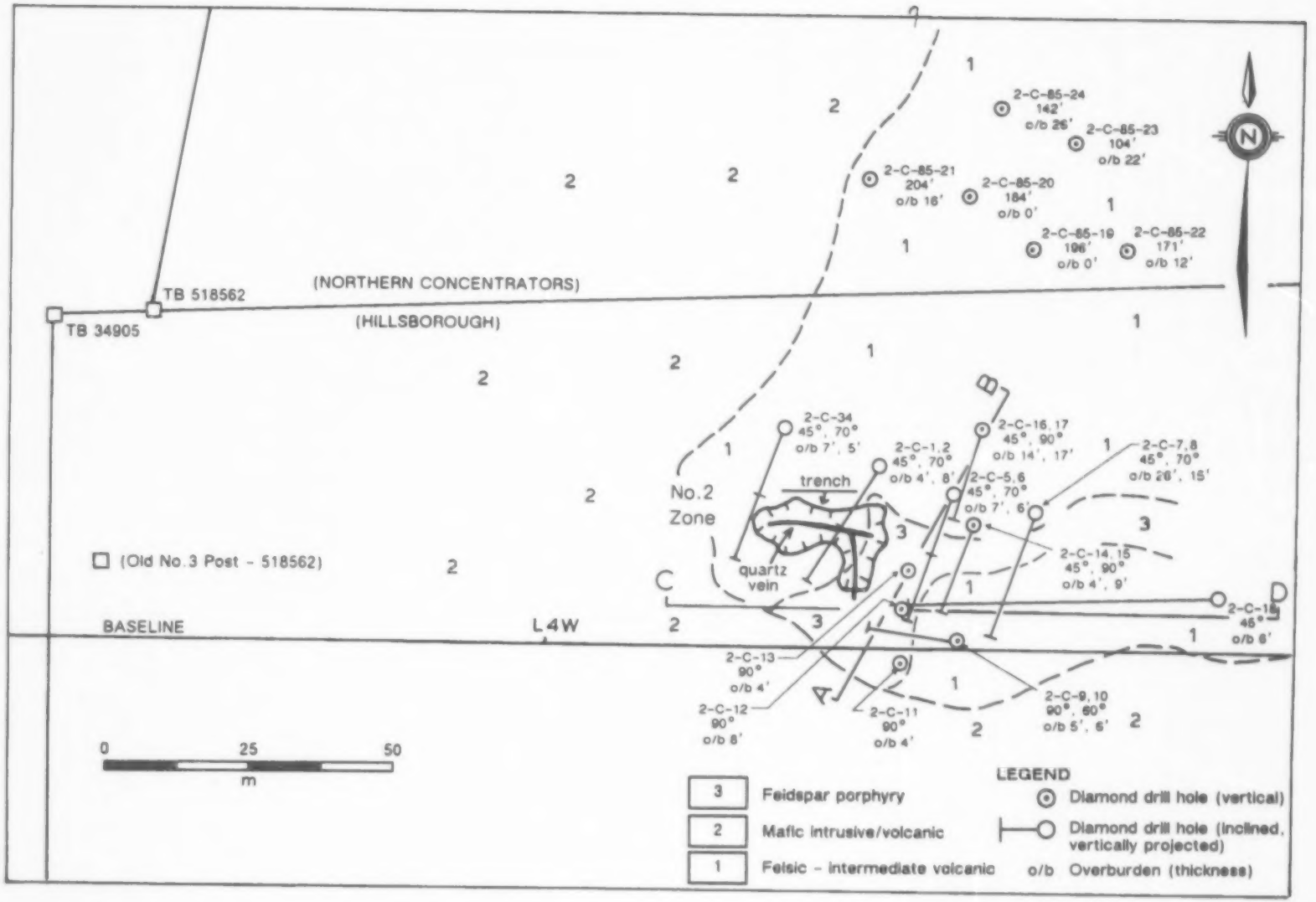

Figure 19. *Geological sketch plan showing the position of diamond-drill holes at the No. 2 zone, Crooked Green Creek property, Pifher Township (1983 and 1985 drilling programs); after data in Assessment Files Research Office, Ontario Geological Survey.*

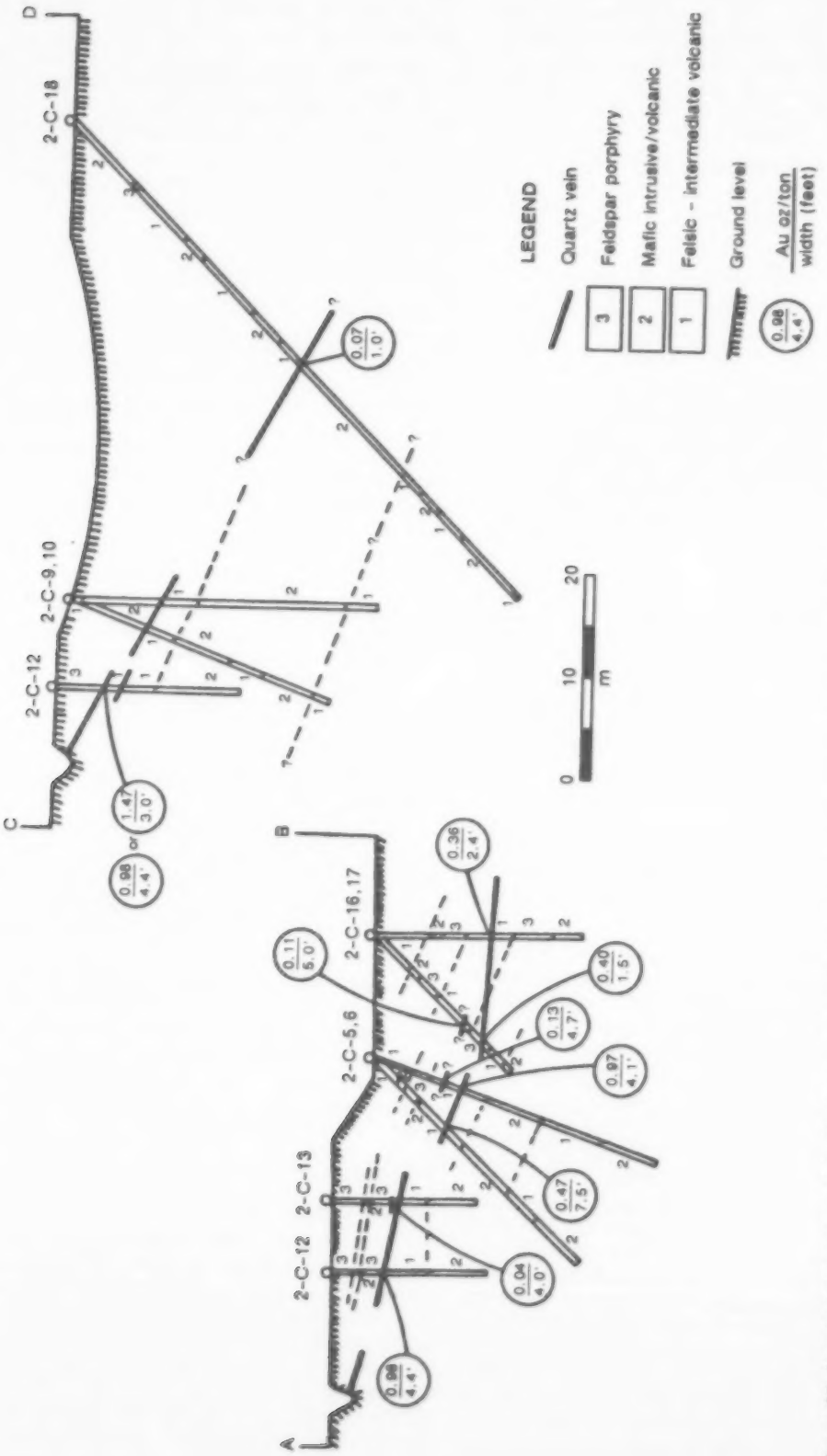

Figure 20. *Longitudinal sections of the No. 2 zone, Crooked Green Creek property, showing the position of the diamond-drill holes from the 1983 and 1985 drilling programs and gold mineralized intersections. Sections A–B and C–D are shown on Figure 19; after data in Assessment Files Research Office, Ontario Geological Survey.*

Directly overlying the flow unit to the southeast are monolithic lapilli tuffs and tuff breccias. The northern part of the property is underlain by gabbro, andesite flows, and small, feldspar and feldspar-amphibole porphyry stocks of irregular shape. All rocks throughout the property are intruded by northwest-trending feldspar porphyry dikes.

Numerous quartz veins are found throughout the area. Some of these, such as the No. 1, 2, and 4 zones, are abundantly mineralized with sulphides and gold.

The No. 1 zone is represented by an east-trending quartz vein that has been traced over a distance of approximately 80 m. The vein dips to the south at between 45° and 70° and has a thickness of 0.3 to 0.6 m near the shaft (Mason and McConnell 1982). Due to mining of the vein on surface, little of it remains to be seen aside from its easterly and westerly extensions, and narrow offshoots which branch away from the main vein near the shaft. The vein is emplaced at the contact between andesitic to dacitic volcanic rocks and a dark grey, massive feldspar porphyry (*see* Figure 22, back pocket) with up to 40 percent white plagioclase phenocrysts.

Feldspar porphyry makes up most of the waste that has been removed from the shaft and the trenches. The presence of occasional aphyric fragments up to several centimetres in size, casts some doubt as to the intrusive nature of the porphyry; the great homogeneity in turn supports an intrusive origin, the fragments having probably been mechanically introduced.

The No. 2 zone is, from a structural point of view, analogous to the No. 1 zone, where the vein system occurs at the contact between felsic to intermediate volcanic rocks and gabbro. The volcanic rocks show a conspicuous banding which is attributed to igneous flow banding.

Mason and White (1986) report that the No. 2 zone consists of a minimum of three veins that resemble the No. 1 vein in terms of texture and colour. From drill hole data, it appears that two of the veins are dipping to the east and south, respectively, at between 20° and 39° (*see* Figure 19, Figure 20). According to Mason and White (1986), the two veins cut a third vein having a steeper dip, but eventually all three veins merge at depth. The vein previously exposed in a 20 m long pit has been largely quarried out.

The No. 4 zone, of lesser importance, is situated on the north shore of Chellew Lake (local name), 150 m southeast of the shaft (*see* Figure 22, back pocket). It consists of a series of interconnecting quartz veins and stringers which trend east. Visible mineralization consists of disseminated pyrite and chalcopyrite. One grab sample, taken by the field party, returned 290 ppb Au. Mason and White (1986) report that 80 samples, taken over a length of 150 feet (46 m) and over a width of 80 feet (24 m), yielded an average 0.22 ounce gold per ton. In addition, one sample is reported to have assayed 0.12 ounce gold per ton and 0.25 percent copper over a width of 9.1 m.

Between the No. 1 and the No. 2 zones, on the northwestern side of Chellew Lake (local name) a recently blasted pit, exposing a series of irregular quartz veins was located by the field party. The veins consist of glassy quartz with numerous vugs and are abundantly mineralized with pyrite and chalcopyrite. One grab sample yielded an assay value of 1020 ppb Au and 5 ppm Ag.

MINERALIZATION—NO. 1 & NO. 2 ZONES

The vein material at both the No. 1 and the No. 2 zones is very similar, consisting of dark grey glassy quartz as well as lighter quartz. The quartz is mineralized with patches and stringers of sulphides. In decreasing order of abundance these are chalcopyrite, pyrrhotite, sphalerite, and pyrite (Andrews 1973). Gold occurs in the free state, commonly as grains and small nuggets associated with sulphides. Visible gold was found by the field party in a narrow, milky quartz vein near the shaft.

The average grade of the No. 1 vein, calculated from the ore mined in 1980 and 1982, was 0.26 ounce gold per ton from 915 tons of ore; No. 2 zone indicated a grade of 0.42 ounce gold per ton from a total of 540 tons of ore (Mason and White 1986). It is assumed that the ore was sorted prior to milling. One selected grab sample taken at the No. 2 zone assayed 32.32 ounces gold per ton and 4 ppm Ag. Such high values, when compared to the average grades listed above (*see* Figure 20) suggest that the gold is erratically distributed.

Silver content appears to be low in the vein material. The highest silver value obtained from samples collected by the field party, 10 ppm Ag together with 1170 ppb Au, was from a specimen taken at the eastern extremity of the No. 1 vein, where the host rock is gabbro.

Ore reserves calculated from diamond drilling intersections were estimated at 25 000 tons grading 0.35 ounce gold per ton for the No. 1 zone and 7500 tons at 0.36 ounce gold per ton for the No. 2 zone (Beardmore–Geraldton Resident Geologist's files). The deposit appears to be one of small tonnage with moderate to high grades.

PHOENIX GOLD MINES LIMITED

Sturgeon River Mine

In 1986, Phoenix Gold Mines Limited held 35 contiguous surveyed mining claims in Elmhirst, Irwin, and Pifher Townships. The property is composed of the original Sturgeon River Gold Mines Limited claims (TB 13641 through 13647, and TB 25967 through 25972), the Macjoe Sturgeon Gold Mines Limited claims (TB 13931 through 13933, and TB 16726 through 16734), and the Agaura Exploration Limited claims (TB 13392 through 13400, and TB

13403) (Halladay 1985), which cover a total area of 1623 acres.

Discovered in 1934, the Sturgeon River Mine produced 73 438 oz of gold and 15 922 ounces of silver from 1936 through 1942 (Sinclair et al. 1936; Sinclair et al. 1937; Sinclair et al. 1938; Sinclair et al. 1939; Tower et al. 1940; Tower et al. 1941; Tower et al. 1942; Tower et al. 1943). Mining operations ceased in 1942, due to a labor shortage. However, much exploration work on surface has been undertaken since. The deposit is situated south of the Namewaminikan River at the common corners of Irwin, Pifher, Walters, and Elmhirst townships, and occurs at the southern end of a quartz diorite stock.

Gold is associated with quartz veins that cut both volcanic and intrusive rocks.

HISTORY AND PRODUCTION

A detailed account of past activities, to 1968, at the Sturgeon River Mine property is given by Mackasey (1975) and Mackasey and Wallace (1978). An updated data compilation including history, past production figures and the geology of the deposit is summarized by Mason and White (1986).

A detailed description of the mine and its geology is also given in Bruce (1936, p.36-48). Descriptions of mining activities and production are listed in Sinclair et al. (1936, 1937, 1938, 1939) and Tower et al. (1940, 1941, 1942, 1943).

Claims TB 13641 and TB 13647 were originally staked, in 1934, by J.M. Wood and W.T. Brown. Sturgeon River Gold Mines was incorporated and carried out trenching, sampling, and diamond drilling on vein No. 3 (*see* Figure 23, back pocket) on claim TB 13642; this is the site of the original discovery. A 3-compartment shaft was sunk on vein No. 3, in 1935, to a depth of 523 feet (159.4 m) and four levels were established. A second auriferous quartz vein, vein No. 10, was intersected at a depth of 375 feet (114 m). Trenching exposed 1000 feet (305 m) of the No. 3 vein, of which 560 feet (171 m) were reported to contain high-grade ore (Mason and White 1986). Production started in 1936 and a mill was installed the same year. Mining activity continued until 1942 when gold mining became a non-war industry and the mine was forced to close. Exploration resumed in 1944. A summary of mining, production and development data is listed in Table 14.

In 1964, Sturgeon River Mines Limited was renamed Quebec Sturgeon River Mines Limited; the property was sold to Coniagas Mines Limited in 1967.

In 1972, Jupiter Minerals Incorporated was formed to hold the original Sturgeon River property. An exploration program consisting of trenching and geophysical and geochemical surveys was initiated to assess potential for base metals, and to re-evaluate the property for gold. Jupiter Minerals Incorporated was renamed Phoenix Gold Mines Limited in 1975.

In 1981, an 8-ton bulk sample was removed at surface from the No. 3 (production) vein for a test of auriferous vein material using a colourimetric sorter. Halladay (1985) reports the following assay results:

white quartz component—2.527 ounces gold per ton

dark wall rock component—0.923 ounce gold per ton

In 1984, a major exploration program was initiated to evaluate the property. A control grid covering all 35 claims was cut. Exploration work consisted of geophysical surveys (ground magnetometer, VLF-EM), geological mapping, prospecting, and sampling of vein material. Early in 1985, a diamond drilling program was started (drill hole locations shown on Figure 23 (backpocket). During the summer of that year, field work consisted of extensive, follow-up overburden stripping of quartz veins, channel sampling of vein material, geochemical soil sampling over areas of glacial overburden and further geological mapping and prospecting (Halladay 1985). Much of the same type of work was carried out during the 1986 field season.

GEOLOGY

Much of the property lies outside the present project area and has not been thoroughly investigated by the present survey. The Sturgeon River Mine property straddles four separate map areas, three of which have been the subject of previously published maps and reports. The northeastern quarter of the property is included in the area described by Mackasey and Wallace (1978). The southeastern margin of the property occupies the northwestern corner of Walters Township mapped by Mackasey (1976a, 1976b). The southwestern part of the property, including the mine area, lies in Irwin Township (Mackasey 1975). Bruce (1936) gives a detailed geological description of the area in the immediate vicinity of the No. 3 vein.

The Sturgeon River property is underlain by intermediate to felsic metavolcanics, which are intruded by granitic rocks of intermediate composition in the northern part of the property. Between the volcanic and plutonic rocks is a northeast-trending, fine-grained, intermediate porphyry several hundred metres wide.

The part of the property in the southeastern corner of Pifher Township is underlain by granitic rocks that form the southern extension of the Elmhirst Lake stock (Mackasey and Wallace 1978). In the field, these rocks are massive to foliated and weather to a buff colour with green spots. From petrographic examinations, the major constituents are plagioclase, quartz, and hornblende that has degraded to actinolite. No potassic feldspar was observed in a stained specimen. Mineralogically, the rock is essentially a hornblende-bearing quartz diorite which is locally dioritic and tonalitic in composition. Alteration of plagioclase to saussurite and sericite, and the degradation of hornblende to actinolite, suggests that these intrusive rocks have been metamorphosed.

In northern Irwin Township, the volcanic rocks have been described by Mackasey (1975) as massive to foliated and ranging in colour from medium grey to dark green. One exposure, visited during the current work, consists of a spherulitic rhyolite which weathers white on surface. Individual spherulitic bodies range up to 2 to 3 cm in size. Halladay (1985) describes this type of rhyolite as "being common" on the Sturgeon River property.

The central part of the property, in southwestern Elmhirst Township and northeastern Irwin Township, is underlain by porphyritic rocks of intermediate composition. This rock type has been described by Halladay (1985) as massive, fine-grained, with a variable content of white, saussuritized plagioclase phenocrysts. To the southwest of the shaft, the porphyry is interfingered with the volcanic rocks. It is probably a marginal phase to the Elmhirst Lake stock.

Several Proterozoic diabase dikes intersect the Archean lithologies (*see* Photo 24).

A large number of quartz veins have been found on the property, many of which have been followed for considerable distances by overburden stripping. The general trend of these veins is northeast. They occur in all of the three lithologic groups. However, the majority of the veins are hosted by the northeast-trending porphyry body and they are particularly abundant in southwestern Elmhirst Township. Although veins have been followed for distances up to 0.75 miles (1.2 km) (Halladay 1985), widths vary considerably ranging from virtually zero to over 1 m. The No. 3 (production) vein had an average width of 10 inches (25 cm) (Halladay 1985). Quartz veins have been emplaced in 1) shear zones where they are commonly boudinaged and drag-folded (*see* Photo 23), and 2) in tension fractures (*see* Photo 24).

Among the large number of quartz veins, only a few are mineralized with gold. The exploration program undertaken by Phoenix Gold Mines Limited was aimed at finding additional veins similar to the production vein. Two veins with potentially economic gold grades were found: Vein 85M-1 in Pifher Township and Vein 85A-2 in Elmhirst Township. Both veins occupy shear zones.

Overall grades based upon production statistics (Table 14), suggest that the No. 3 vein is evenly mineralized with respect to gold. Mineralization is apparently more erratic in the 85M-1 and 85A-2 veins, but grades become more consistent where the veins widen (L.O. Koskitalo, Phoenix Gold Mines Limited, personal communication, 1986).

Quartz veins on the property commonly have a ribboned structure (*see* Photo 23) imparted by chloritic wall rock material which was produced during vein development by a crack-and-seal mechanism. Most veins consist of milky, coarsely crystalline quartz. A number of veins also contain narrow veinlets of clear quartz which cut the milky quartz. Such veins are almost invariably mineralized with gold (V. Shein, Phoenix Gold Mines Limited, personal communication, 1986). Visible gold is common within the No. 3, 85A-2 and 85M-1 veins; it is mostly found in high grade pockets within the veins. The gold occurs in the free state as micro-fracture fillings and is commonly concentrated along chlorite-sericite partings within the vein. Bruce (1936) reports that the gold within vein No. 3 occurs in the free state both within quartz and pyrite, and also as a gold telluride in pyrite.

Sulphide mineralization in veins occurs as disseminations of pyrite, chalcopyrite, sphalerite, and galena. To the west of vein 85A-2, on the west side of Highway 801, massive pods and lenses of grey sphalerite in a 30 cm wide quartz vein have been noted. Gold mineralization is restricted to the quartz vein; the wall rock is usually barren.

Alteration on the property is normally restricted to shear zones which show obvious signs of sericitization and carbonatization. On claim TB 16730 in Irwin Township, the volcanic rocks have been pervasively affected by boron metasomatism; in one exposure several tens of metres wide, a mafic volcanic breccia shows total replacement of chloritic clasts by black tourmaline (*see* Photo 21). The matrix to the clasts is white and probably consists of silica and white mica (sericite). Quartz veins in the vicinity of the tourmalinized volcanics have been found to be barren of any gold mineralization (L.O. Koskitalo, Phoenix Gold Mines, personal communication, 1986). The total extent of the tourmaline alteration is not known; however, minor tourmaline replacement has been found in volcanic rocks on the north end of the property in Pifher Township, approximately 1 km north of the main tourmaline replacement in Irwin Township.

In the vicinity of the 85-A2 vein in Elmhirst Township, zones of strongly chloritized rock, up to several centimetres wide and centred on narrow fractures, have been noted. Massive magnetite, in bands and lenses up to several centimetres wide, are commonly associated with the chloritic zones.

PODANY MINING CORPORATION

As of September 1986, Podany Mining Corporation held a group of four patented claims north of Twin Falls in Irwin and Pifher townships. The northern half of two claims (TB 10504, TB 10505) are located in Pifher Township. Also held were unsurveyed claim TB 834684 in Pifher Township, and claims TB 834684 through 834687 in Meader Township, all adjoining the patented claims to the west.

The four patented claims were originally held by P.E. Hopkins. The following account is given by Laird (1936, p.99):

"P.E. Hopkins holds a group of four surveyed claims (T.B. 10,501, 10,502, 10,504, 10,505) located just north of Twin Falls on the Sturgeon river, in Irwin and Pifher townships. J.J. Green and G. Brennan found gold on these claims as early as 1931. Their continued interest in this section is said to have

TABLE 14. SUMMARY OF PRODUCTION AND DEVELOPMENT DATA FOR THE STURGEON RIVER MINE.

Year	Ore raised (tons)	Ore milled[1] (tons)	Gold yield (troy ounces)	Silver yield (troy ounces)	Average gold grade from ore milled (oz/ton)	Depth of shaft, in feet (m); Number of established levels	Total drifting, in feet (m)	Total cross-cutting, in feet (m)	Surface diamond drilling, in feet (m)
1935	-	-	-	-	--	523 (159) 4 levels	2817 (865)	713 (217)	3200 (975)
1936	1963	1290	590.7	118	0.458	750 (229) 6 levels	2251 (686)	251 (76)	--
1937	24 946	17 978	8839.4	1917	0.492	774 (236) 6 levels	695 (212)	--	752 (229)
1938	45 697	28 157	14 432.4	3219	0.512	966 (294) 6 levels	1531 (467)	271 (83)	537 (164)
1939	42 541	26 282	12 049.2	2804	0.458	1274 (388) 9 levels	4025 (1227)	650 (198)	--
1940	45 259	27 790	13 304.8	2883	0.479	1780 (542) 12 levels	3032 (924)	422 (129)	--
1941	40 816	25 869	11 887.35	2490	0.459	1780 (542) 12 levels	5399 (1647)	217 (66)	--
1942	31 327	17 757	12 334.8	2491	0.695	2108 (642) 14 levels	489 (149)	625 (190)	--
1943	--	--	--	--	0.506	2108 (642) 14 levels	20 239 (6168)	3149 (960)	4489
Totals	232 549	145 123	73 438.6	15 922					

[1] *The difference in tonnage between the treated ore and the ore raised from the mine results from the hand cobbing of the hoisted ore.*

Information from "Statistical Reviews of the Mineral Industry of Ontario" and "Mines of Ontario" for 1935-1942, in Ontario Division of Mines annual reports, volumes 45 throuth 52.

induced other prospectors to visit the area, resulting in the gold discoveries along the Sturgeon river three years later. The claims are underlain by arkosic tuffs and agglomerate of the Keewatin series. The main showings are located in the northwest quadrant of claim T.B. 10,502 and may be reached by a good trail branching off from the Maloney Sturgeon trail at a point 20 chains north of Twin Falls. Most of the work has been done on the east slope of a steep north-south ridge. Here a few quartz stringers, well-mineralized with pyrite, intersect a somewhat indefinite east-west shear zone in light-weathering, arkose-like tuff, which is interbedded with agglomerate. Farther along the trail in the southern part of claim T.B. 10,505 are large, irregular, lens-like masses of quartz in schistose arkosic tuff. This quartz is rusty in places but appears to carry no mineralization other than a little pyrite. In the central part of the same claim an east-west vein of white milky quartz, 3 feet wide, has been traced up the east side of a steep hill and exposed for about 80 feet. No important mineralization was observed. No further surface exploration was carried out on this group of claims during the summer of 1935."

A 1 m wide, northwest-trending shear zone on the south side of a small lake, locally known as "Little Max Lake", is mineralized with a 10 cm wide, pyrite-rich band which runs parallel to a several, centimetre wide, discontinuous quartz vein. The mineralization occurs at the widest part of the shear, close to the water's edge, on the south side of a steep rock face, and may be exposed only during low water levels. A pyrite-rich grab sample was taken for analysis and returned 0.14 ounce gold per ton. No signs of any previous work was noticed at this occurrence. The shear occurs in felsic volcanic rocks representing crystallophyric and lapilli tuffs and tuff breccia which are well exposed on the lakeshore.

Stratigraphic-facing structures include normal grading of lithic fragments and reverse grading of pumice (fiamme). The exposure also displays a spectacular cross-cutting cleavage relationship (*see* Photo 18). The showing mentioned by Laird (1936) appears to fit the description of the "Little Max Lake" showing; however, the latter is situated in the northeast quadrant of claim TB 10502.

A. ROSENBLATT

A. Rosenblatt held a block of 15 contiguous claims (TB 835343 through TB 835345 and TB 861862 through TB 861872) in northeastern Pifher Township in September, 1986. The earliest recorded work on the property was in 1947 by an unidentified party that conducted trenching and diamond drilling aggregating 100 m.

In 1966, Portrose Explorations Limited drilled one hole of 147 m on present claim TB 861867. No assays were reported.

In 1972, Labrador Exploration (Ontario) Limited carried out electromagnetic and magnetic surveys, geological mapping, and rock geochemical sampling over 40 contiguous claims which included the western half of the Rosenblatt claims.

In 1977, J. Wodian tested for mineralization on claims TB 861865 and TB 861866 by overburden stripping and trenching.

The property is underlain by felsic volcanic rocks intruded by feldspar porphyry dikes and stocks and small bodies of quartz diorite.

A distinct airphoto lineament crosses claims TB 861865 and TB 861866 in a northeast direction. This lineament marks the contact between feldspar porphyry to the west and heterolithic tuff breccia to the east. A mineralized zone, which outcrops on this lineament approximately on the boundary with the J.P. Sheridan property (*see below*) 700 m north of Miner Lake, was noted during the current work. Mineralization consists of chalcopyrite, pyrrhotite and pyrite in small quartz veins within shear zones striking 110°; they are exposed over 3 m. The wall rock to the quartz veins is chloritized. A grab sample of vein material returned an assay value of 60 ppb gold.

J.P. SHERIDAN

Greenspar Property

In 1986, J.P. Sheridan held a group of 12 claims (TB 604844 through TB 604846, TB 604864, TB 604867 through TB 604874) in the northeast quadrant of Pifher Township. The property has been intermittently investigated since the 1930s for gold and base metals.

HISTORY

The Reed–Coyne Partnership staked a group of 20 claims just north of Miner Lake in 1936. Stripping and trenching was conducted on a zone of sulphide mineralization, although no assays were reported (Laird 1936).

An electrical resistivity survey was performed by Continental Exploration Limited in 1953, on the eastern portion of the property.

In 1964, Greenspar Mines Limited staked six claims over the former Reed–Coyne claim group. By 1965, the company completed a reconnaissance self potential survey, an electromagnetic survey, a program of prospecting, trenching, and a diamond drilling campaign of four short holes for a total of 141 m (Tyson 1965a). The mineral commodity of interest at the time was copper. In 1969, Greenspar Mines Limited drilled an additional two holes on the property, for a total of 96 m.

Between 1970 and 1977, J. Wodian conducted trenching on the Greenspar property.

In 1981, the property was staked by E. Nelson, J. Nelson, and A. Kapush (Mason and White 1986), it was optioned to Anyox Metals Limited the following year. An electromagnetic survey delineated three conductors, the strongest of which was traced for 600 m in an east-northeast direction. A diamond-drilling program of four holes for a total of 590 m, was performed, in 1983, to test the conductors. The best assays obtained include 0.023 ounce gold per ton over 3.3 feet (1.0 m), 0.226 ounce silver per ton over 1.0

feet (0.3 m), and 0.25 percent copper over 0.6 feet (0.1 m) (Assessment Files Research Office, Ontario Geological Survey).

GEOLOGY

The Greenspar property is underlain by intermediate metavolcanics consisting of tuff and heterolithic tuff breccia which are intruded by a feldspar-hornblende porphyry stock and a small body of diorite to quartz diorite.

The rocks in the north end of the property are intersected by a series of narrow shear zones, striking northwest over an exposed length at 400 m; they are occupied by veins of quartz and veinlets of chalcopyrite and pyrite. The surface of rock exposures in the northern part of the property is stained by limonite which is produced by the weathering of finely divided pyrite.

MINERALIZATION

Sulphide mineralization occurs in several zones in the north-central and northwestern portions of the property. These zones collectively make up the Greenspar copper-gold occurrence. Mineralization consists of pyrite, chalcopyrite, and pyrrhotite occurring as narrow sulphide seams in shear zones and as patches in occasional quartz veins.

Mason and White (1986) describe the Greenspar occurrence as two main showings. One showing, situated 800 m northwest of Miner Lake, is within a 9 m wide, vertical shear zone in diorite and feldspar-hornblende porphyry.

A second showing is situated 190 m east-southeast of the former showing and is exposed in a 17 m long trench about 200 m west of a small pond. A southeast striking quartz vein with an average width of 20 cm is mineralized with pyrite and chalcopyrite. Disseminated pyrite is common in the feldspar-hornblende porphyry hosting this vein.

A vertical shear zone striking 120° occurs in a quartz diorite outcrop 50 m south of the quartz vein. The shear is about 1 m wide and contains veinlets of pyrite and chalcopyrite. A grab sample, taken by the field crew, assayed 24 ppb gold. The quartz diorite host rock is silicified for 25 cm on either side of the shear zone. This small shear zone can be traced northwest along strike for over 100 m in a series of old trenches.

A quartz vein 0.3 m wide was found by the field party approximately 800 m to the west of the showing described immediately above. The vein strikes 40° and is mineralized with minor pyrite. The wall rock of the vein consists of pyrite-bearing chlorite schist. A grab sample of vein material obtained by the field crew assayed 550 ppb gold.

P. SKALESKY AND J. TERNOWESKY

Atlantic Mining Corporation–Noranda Exploration Limited Option (Twin Falls Occurrence)

A 41-claim group (TB 746739 through TB 746779), centred on the Pifher–Irwin township boundary north of Twin Falls on the Namewaminikan River, was staked in 1983 by P. Skalesky and J. Ternowesky. In 1985, the 41 claims were optioned to Atlantic Mining Corporation of Minneapolis, Minnesota. An airborne magnetic-electromagnetic survey was flown in October 1985, by Terraquest Limited (Assessment Files Research Office, Ontario Geological Survey). Ground work consisted of overburden stripping and channel sampling on a wide, mineralized shear zone known as the "Twin Falls Occurrence" which is situated in the extreme southwest corner of the claim block in northwestern Irwin Township (Mason and White 1986).

During the summer of 1986, Noranda Exploration Limited engaged in further stripping and trenching in the main zone and its vicinity, exposing the shear in a large pit. Several shear zones and quartz veins occur elsewhere on the property in both Irwin and Pifher townships.

Ground geophysical surveys, geological mapping and prospecting were carried out on the entire property along surveyed grid lines.

Past exploration on the property goes back to 1934 when the Cyril Knight Prospecting Company Limited undertook surface work on a group of six claims near the confluence of Crooked Green Creek and the Namenaminikan River, where gold had been found in a narrow quartz vein (Laird 1936).

A second gold showing was discovered by A. Milroy and R.S. Taylor in 1934, just north of the Pifher–Irwin township line and 2.3 km east of the Pifher–Meader township boundary on the west shore of a small lake locally known as "Turtle Lake". In 1986, it was covered by claim TB 746749. The showing is reported to consist of a 9-inch (23 cm) wide quartz vein striking in a northwesterly direction and dipping steeply south. Specks of visible gold were observed in material from the vein (Laird 1936).

A group of nine claims was staked around the showing in 1934. In 1935, the property was optioned to Tellaurum Gold Mines Limited; further prospecting resulted in the discovery of several mineralized quartz stringers from which gold pannings were obtained (Laird 1936). The option was relinquished later in the year because of the small economic importance associated with the findings (*The Northern Miner*, August 1, 1935).

The current property is entirely underlain by felsic volcanic rocks. The main showing, the Twin Falls occurrence, consists of a 60 m wide, 800 m long, east-trending, steeply dipping shear zone in fragmental felsic volcanics. The shear zone is characterized by sericite schist pervasively mineralized with dissemi-

nated pyrite. A 10 cm wide massive pyrite vein with a vertical dip is exposed at the centre of the shear (*see* Photo 25). The vein is in sharp contact with the adjacent wall rock; it consists of pyrite set in a siliceous boxwork. A grab sample collected by the field party returned 0.32 ounce gold per ton upon analysi; silver was not detected. Mason and White (1986) report a value of 0.74 ounce gold per ton for a sample taken from the same vein. The pyrite vein is deeply weathered on surface and only a gossan consisting of a siliceous boxwork stained with limonite (*see* Photo 26) remains. One analysis done on weathered boxwork material returned 861 ppb gold.

A second shear zone, 700 m southeast of Peddle Lake, has been exposed over a width of 40 m by overburden stripping. The shear zone consists of narrow, erratic, pyrite-bearing quartz veins in a silicified felsic tuff. A grab sample of a silicified sericite schist assayed 65 ppb Au.

A third shear zone is exposed in southern Pifher Township, in a 10 m wide outcrop 900 m west of the bridge over Crooked Green Creek. Fifty-seven, narrow, parallel, pyrite-bearing quartz veins, striking 120° and dipping 75°, are hosted by sericite schist (*see* Photo 14).

D. THORSTEINSON ESTATE

In 1986, D. Thorsteinson held two claim blocks in the map area. Ten contiguous claims (TB 815272 through TB 815281) were located in east-central Pifher Township. A second group of 50 contiguous claims (TB 873956 through TB 873975, TB 907401 through TB 907405, and TB 907451 through TB 907475, was located in central Barbara Township.

The 10 claims in Pifher Township were under option to Sweany Gold Corporation in 1986. During the summer of 1986, Terraquest Limited flew airborne magnetic and electromagnetic surveys for Sweany Gold Corporation over the Pifher Township claim group.

No other assessment work is on file for either claim group.

The Pifher Township claim group is underlain by intermediate flows, lapilli tuff, tuff breccia, and diorite and quartz diorite of the Elmhirst Lake Stock.

The Barbara Township claim group is underlain mainly by mafic, pillowed and massive flows, intermediate tuffs and lapilli tuffs and gabbro. No mineralization was noted by the field party on either claim block.

J. WENZOSKI [1976]

In 1976, J. Wenzoski held two claims (TB 350331, TB 350333) in northern Pifher Township, on the east side of McConnell Lake. Stripping and trenching on the property was reported that year (Resident Geologist's files, Thunder Bay).

The property is underlain by monolithic, intermediate to felsic, recrystallized tuff breccias cut by north-trending granitic and gabbro dikes.

Mineralization consists of thin chalcopyrite and pyrite stringers in tuff breccia; the stringers are parallel to foliation and of limited extent. A grab sample of rusty pyritic material assayed 17 ppb gold.

487219 ONTARIO LIMITED

Greenoaks Mine

In 1986, the company held a group of 15 contiguous leased claims, 8 of which (TB 35563 through 35567, TB 34818 through 34820) are in eastern Pifher Township and 7, in Elmhirst Township. The property has been explored on several occasions for gold and base metals. Much work took place in 1986, including the removal of ore from the main zone.

HISTORY

Four zones, including the main gold showing (No. 1 zone), were discovered by A.E. Rissanen in 1947, on claim TB 35563. Stripping, trenching, and diamond drilling of 22 holes with an aggregate length of 449 m, were completed the same year on the No. 1 zone.

In 1953, the property consisted of 15 claims held by Greenoaks Mines Limited (a lease for the claims was obtained in 1954). Electrical resistivity, ground magnetometer and geological surveys were carried out that year and three diamond-drill holes, for a total of 509 m, were drilled to test resistivity anomalies but little was found.

In 1960, a detailed magnetometer survey, detailed geological mapping and photogeological interpretation were undertaken. This work was followed by diamond drilling of five holes, for a total of 302 m.

W. Miron and 487219 Ontario Limited optioned the property in 1981. In 1982, 1224 tons of ore were mined by Thyssen Mining Construction (Canada) Limited for W. Miron (Mason and White 1986). The property was optioned, in 1983, to Turner Energy and Resources Limited of Vancouver, B.C., who carried out geophysical, geological and sampling work along with diamond drilling of six holes, for a total of 315 m. The property was held in 1985 by W. Miron.

Visits by the field party during the summer of 1986 indicated that the main zone was further mined and that bulldozer stripping was undertaken, mostly to the west and north of the main zone.

GEOLOGY

In Pifher Township, the Greenoaks property is mostly underlain by felsic to intermediate, tuff, lapilli-tuff and tuff breccia of both monolithic and heterolithic character. These rocks are intruded by numerous northwest-trending feldspar porphyry dikes, and by part of a porphyry stock in the southern part of the property. Little structural information has been aquired, due to the relative homogeneity of the rocks. The geology of the property in Elmhirst Township has

been described in Mackasey and Wallace (1978), who reported that "metavolcanic and intrusive lithologies are indistinguishable in that area". Veins mineralized with sulphides and gold occupy tension fractures occur near the Pifher–Elmhirst township line.

MINERALIZATION

Geophysical work, including resistivity studies, which were conducted on the property in 1952, indicated several anomalies (Assessment Files Research Office, Ontario Geological Survey). Little of economic importance was found by the subsequent drilling program. The most significant occurrence to date on the property is the so-called main zone on claim TB 35563, representing the original showing where gold was found in 1947.

The main zone consists of a quartz vein trending 100°. It is hosted by a massive feldspar-amphibole porphyry dike, situated at the eastern foot of a hill. According to the dimensions and orientation of the main trench, the vein is 50 m long on surface and is dipping to the west at 70°. Its thickness appears to be variable along strike. Little shearing appears to be associated with the vein.

The vein is mineralized with patches and stringers of pyrrhotite, chalcopyrite, and lesser pyrite, which locally may constitute one third of the vein material. Native gold, found as visible specks, is intimately associated with the sulphide mineralization. One grab sample taken by the field party returned 11.17 ounces gold per ton and 4.29 ounces silver per ton. The quartz, ranging from white to black in colour, is highly fractured with large glassy eyes.

On the slope of a hill 200 m to the northwest of the main zone, the field party found a 60 cm wide quartz vein poorly exposed along a freshly bulldozed path. The vein, which trends 040°, consists of a smoky, glassy quartz variously mineralized with small masses of chalcopyrite and pyrite. One grab sample returned 1570 ppb Au and 6 ppm Ag. The host rock to the vein has not been determined.

Both the latter vein and the main zone fall along a photo-lineament trending 130°. Length of the vein system is unknown.

OTHER PROPERTIES

The following individuals held claims in the map area as of September 22, 1986. No work on these properties was on record at the Assessment Files Research Office, Ontario Geological Survey, as of December 31, 1986.

P. Betcherman held 23 claims (TB 928758 through TB 928771 and TB 939495 through TB 939503) in the eastern part of Pifher Township.

G. Bruce held one claim (TB 861785) in central Pifher Township.

The two leased claims of A.P. Hopkins (TB 28881 and TB 28884) on the Pifher–Irwin township line, are part of a block of six leased claims in Irwin Township.

T. MacAdam held a block of nine claims (TB 941623 through TB 941631) in central Meader Township.

R. Melanson held 45 claims (TB 925953 through TB 925962, TB 925964 through TB 925969, TB 925971 through TB 925976, TB 925978 through TB 925983, TB 925985 through TB 925990, and TB 925992 through TB 926002) in central Barbara Township.

A. Nabigon held 42 claims (TB 874289 through TB 874330) in Meader Township.

M. Peplinski held a block of 100 claims (TB 909701 through TB 909731, TB 909733 through TB 909756, TB 909758 through TB 909774, TB 909777 through TB 909780, TB 909782 through TB 909786, TB 909788 through TB 909797, TB 909800, TB 901668 through TB 901671, and TB 915439 through TB 915443) in Meader and Barbara townships.

G. Thurston held a block of 56 claims (TB 909558 through TB 909563 and TB 926053 through TB 926102) in northern Barbara Township.

Suggestions for Mineral Exploration

Within the present map area, gold is the most promising mineral commodity. The easy access to the area provided by several gravel roads and the proximity of the Trans-Canada Highway, coupled with nearby electric power and ample water supply, would contribute to the rapid and relatively inexpensive development of any deposit in the area. The delineation of a gold deposit in central Irwin Township, reported to have a potential tonnage of two million tons of ore (*The Northern Miner*, July 21, 1986) with grades ranging from 0.2 to 0.7 ounce per ton in drill intersections (*The Northern Miner*, March 24, 1986; March 31, 1986), suggests the map area has high potential for future gold discoveries. The geological environment also offers good possibilities for small, high-grade deposits.

The distribution of gold deposits provides evidence that certain geological features had a major control on gold mineralization. These controlling factors are: 1) major faults with associated ductile shear zones, 2) lithologic contacts between contrasting rock types that focussed ductile and brittle fracturing during deformation, 3) fold axes, and 4) zones of pervasive alteration which may display secondary mineralization such as silica, alkali feldspar, carbonate, tourmaline, and disseminated sulphides. Special attention should be given to topographic linear features which appear on aerial photographs, as they may represent surface expressions of lithologic contacts or fracture zones. The Musca Lake Fault is a significant structure along which several gold showings have been discovered and which merits further attention, particularly between Musca Lake in Sandra Township and Little Lake in Barbara Township.

Previous mapping by Laird (1936) resulted in the misinterpretation of certain rock types in Pifher Township. For example, gabbro in the central part of the township was mapped as Proterozoic diabase, and recrystallized metavolcanics in the northern part of the township were not distinguished from granitic rocks. This information has probably had the effect of discouraging mineral exploration in those areas.

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